SERVICE CENTRES AND RURAL-URBAN INTERACTION IN THE NORTH WEST MIDLANDS; An appraisal of measures of centrality within the lower orders of a central place system.

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Submitted for the
degree of Ph.D. at
The University of Keele. 1971

ABSTRACT

Service centres and rural-urban interaction in the north-west Midlands; an appraisal of measures of centrality within the lower orders of a central place system.

This thesis is concerned with a comprehensive analysis and interpretation of the functional status and pattern of distribution of service centres in a rural part of England, and with the way in which these centres interact with their hinterlands.

It commences with a review of the published work in this field, partly in order to try to introduce some order and thematic classification into the diverse range of contributions from many disciplines which have followed from Christaller's work of the 1930's, and partly in order that this study may be seen as a logical progression from earlier work. The main themes of central place study are critically examined, although in order to avoid needless repetition with other studies the emphasis is laid upon material which has appeared since 1964. Some of the ideas and problems discussed are taken up in more detail in subsequent parts of the text.

The first main section (Chs.3-6) deals with the measurement of settlement centrality, and the question of grouping settlements into a functional hierarchy. A measure of the functional complexity of towns and villages in the survey area is built up from information gathered from a variety of published sources, and from detailed field investigation. By the use of location coefficients an index of functional status is devised, and this is used as the basis for arranging the settlements into a ranked order of size.

Retail functions are considered as but one element of a settlement's total functional composition, and in order to broaden

the base of measurement, particularly for smaller centres, service functions and social facilities are also examined. In addition, the complex inter-relationships of these functions, both within individual centres and across the whole range of settlements, are discussed.

Several alternative approaches to the measurement of centrality are presented and compared, but it is the method based upon each settlement's provision of retail and service facilities which forms the first part of the procedure for ranking centres into a functional hierarchy. Different ranking and clustering techniques are examined, and an iterative grouping procedure which produces a logical statement of the hierarchy, together with a measure of accuracy for each inter group boundary, is explained and implemented. This method, which is described in chapter 6, scans a list of settlements, each of whose functional status is expressed as a single numerical score, and systematically amalgamates the most similar items into a subset. Similarity in this context is measured in terms of the Error Sum of Squares, and a hierarchy with eight distinct orders of settlements is described.

It is suggested that measures based solely upon a centre's functional provision give a very restricted, and often inaccurate, assessment of centrality. In order to avoid this, and in an attempt to illustrate a totally different facet of the involved concept of centrality, the second section is devoted to an analysis of the use characteristics of the service centres and the nature of their zones of influence. The information upon which this section is based was mostly gathered by means of a postal questionnaire survey.

An examination of the journeys made to towns and villages for shopping and for services, forms the initial part of an investigation into the way in which these centres exert their influence over the surrounding rural areas. The frequency of such visits, and their destinations, are analysed and a nodal structure of the area is

outlined. A consideration of the journeys to shop for a selected list of goods and services leads to several qualifications to the concept of the range of a good being suggested.

The delimitation of urban hinterlands by both theoretical and empirical means is discussed, and several different hinterlands are constructed and compared for the towns in the study area. The boundary of a town's hinterland is in fact a zone of transition, and there is shown to be considerable overlap between the areas of influence of adjacent towns. There are also certain areas, in the interstices in the network of urban hinterlands where no town exerts a dominant influence. Individual rural people however are dominated very strongly by a single town for the provision of goods and services.

Empirical hinterlands are constructed for the main urban centres, and the internal structure of these areas is examined. It is suggested that there is considerable variation in the strength of a town's influence throughout its hinterland, with the main independent variable being distance. The decline of a town's influence with distance for a number of different measures, can be described in general terms by a negative exponential function. The precise nature of this distance-decay function, and the numerical value of the exponents, is shown to vary according to the grade of the town. In this respect two distinct regimes of influence are shown to exist for grade 1 and grade 2 centres, thus confirming the distinction between these two orders previously found on the basis of their functional provision.

Finally the irregularities of the hinterlands of the towns in the study area are discussed, and the characteristics of grade 1 and grade 2 hinterlands for a range of different goods and services are outlined.

General conclusions are presented at the end of sections I and II, and the text is accompanied by fifty figures, thirty-six tables and five technical appendices.

ACKNOWLEDGEMENTS

During the preparation of this work many people have given me advice, assistance and support. I am most grateful for all the help which I have received and the thesis would be incomplete without a record of my thanks to the following :-

Professor S.H. Beaver, Head of the Geography Department, University of Keele, where this research was undertaken.

The Department of Education and Science, and the University of Keele for financial support.

Professor H.B. Rodgers, whose guidance and judgement was invaluable at all stages of the work.

My wife, for her willingness to take second place at atimes, and for her assistance in checking the typescript.

My parents for their continued support and encouragement.

Mrs. F. Grundy, University of Keele, for advice and assistance with the computer program

My colleagues at the University of Keele for their discussion and friendly criticism.

The Secretaries of Staffordshire, Shropshire and Cheshire Community Councils for help with the study of village social organisations.

The staff of the Cartographic Section, Geography Department, University of Keele for their advice and assistance in preparing the maps and diagrams.

Mrs. M.T. Amphlett, who patiently typed the script.

Although I am deeply indebted to all of these people I must also record my sole responsibility for any errors or omissions which occur.

Philip T. Kivell.
1971

CONTENTS

		Page No.
Preface		
Chapter 1.	An outline of central place theory and a review of the conceptual models.	1
Chapter 2.	A critical discussion of empirical approaches to central place study	21
Chapter 3.	Centrality, and the functional complexity of settlements.	56
Chapter 4	Alternative approaches to the measurement of centrality.	92
Chapter 5	Central places of low order	119
Chapter 6	Hierarchies, and the problem of hierarchical grouping.	143
Conclusion to Section I		184
Chapter 7.	The identification of nodal systems and an examination of rural-urban linkages.	187
Chapter 8	The delimitation of urban hinterlands: theoretical and empirical approaches, and the nature of the boundary.	212
Chapter 9.	Hinterlands of rural-urban interaction, the structure of the hinterland.	227
Conclusion to Section II		250
Appendices		253

FIGURES

		Page No.
	Chapter 1	
No.1.1	The theoretical pattern of trade areas (after Christaller).	5
1.2	The theoretical economic landscape (after Losch).	13
	Chapter 2	
2.1	Catchment areas of shopping centres in N.W. Midlands	34
2.2	Conditions favouring the growth of a central place (after Godlund).	39
	Chapter 3	
3.1	Relation between the number of shops and the population of settlements.	74
3.2	Relation between the number of retail and service functions, and the population of settlements.	75
3.3	Relation between the number of retail functions and the population of settlements.	77
3.4	Centres with positive retail loadings.	88
3.5	Centres with positive service loadings.	89
	Chapter 4	
4.1	Relation between the number of retail functions and the number of retail establishments.	94
4.2	The total number of retail establishments in the main centres.	97
4.3	Functional surplus and deficit.	103
4.4	The distribution of settlements showing functional surplus and deficit.	107
4.5	The distribution of market centres in 1927 and 1967	112
4.6	Place of work, administrative areas.	114
	Chapter 5.	
5.1	The relation between village functional scores (retail and service and social) and population.	121
5.2	The relation between village functional scores (retail and service) and population.	125
5.3	Villages for planned expansion.	133
	Chapter 6	
6.1	The population range of settlements in each hierarchical group.	162
6.2	The distribution of settlements in each hierarchical group.	164
6.3	Central place sub-systems in relation to grade 1 centres	165
6.4	The "centrality values" of settlements in each hierarchical group.	169
6.5	The distribution of grade 1 centres.	176
6.6	The distribution of grade 2 centres.	176
6.7	The distribution of grade 3 centres.	177
6.8	The distribution of grade 4 centres.	177
6.9	The distribution of grade 5 centres	178
6.10	The distribution of grade 6 centres	178
6.11	The distribution of grade 7 centres	179

		Page No.
	Chapter 7	
No. 7.1	The location of centres shown in figures 7.2—7.8.	189
7.2	Rural linkages with urban centres: percentage of units.	190
7.3	Rural linkages with urban centres: frequency of visits.	193
7.4	Linkages for grocery shopping.	195
7.5	Linkages for visits to the doctor.	197
7.6	Linkages for chemist's goods.	199
7.7	Linkages for visits to the bank.	201
7.8	Linkages for major clothes shopping.	202
7.9	The linear range of allied groups of goods, and services provided by centres of different hierarchical orders.	208
	Chapter 8	
8.1	Accessibility hinterlands 1947 and 1967.	214
8.2	Theoretical hinterlands for urban centres calculated from Reilly's Law.	216
8.3	Theoretical hinterlands for grade 1 and grade 2 centres calculated from Reilly's Law.	218
8.4	The shopping hinterlands of grade 1 and grade 2 centres.	219
	Chapter 9	
9.1	The distance-decay gradient of population density.	231
9.2	The distance-decay gradient of shopping frequency for grade 1 and grade 2 centres.	235
9.3	The composite distance-decay gradient of shopping frequency	236.
9.4	The varying intensity of the retail hinterlands of grade 1 centres.	239
9.5	The varying intensity of the retail hinterlands of grade 1 and grade 2 centres.	241
9.6	General components of the hinterland.	242
9.7	Specific components of the retail hinterlands of grade 1 and grade 2 centres.	243

TABLES

		page No.
Table 3.1	Functional scores and the ranking of settlements.	65
3.2	Correlation matrix of alternative settlement rankings.	69
3.3	Settlement functions, simple correlation.	72
3.4	The percentages of selected retail and service establishments in each settlement compared with the total distribution	80
3.5	Coefficients of localisation for selected functions.	79
4.1	The proportion of non-food shops and the index of retail centrality.	98
4.2	The functional surplus or deficit of main centres.	101
4.3	External populations served by towns.	109
4.4	Employment in towns as a proportion of residents in employment.	116
4.5	Total daily inward movements of workers.	116
5.1	Villages with centrality scores related to population which diverge by more than one positive standard error from the mean. (retail and service and social scores).	122
5.2	Villages with centrality scores related to population which diverge by more than one negative standard error from the mean. (Retail + service + social scores).	123
5.3	Villages with centrality scores related to population which diverge by more than one positive standard error from the mean. (Retail + service scores).	124
5.4	Villages with centrality scores related to population which diverge by more than one negative standard error from the mean. (Retail + services scores).	126
5.5	Types of village shops.	128
5.6	The distribution of professional/financial services in urban and non-urban areas.	130
5.7	The proportion of villages with selected professional/ financial services.	131
5.8	The distribution of personal services in urban and non-urban areas.	131
5.9	The distribution of county services in urban and non-urban areas.	134

		Page No.
Table 5.10	The proportion of villages with selected county services.	134
5.11	The association between village social organisations.	135
5.12	Village populations and the number of social organisations.	137
5.13	The composition of social organisations in villages	137
5.14	Villages grouped according to their number of social organisations.	140
6.1	Computer print out of the final 20 cycles of the grouping procedure.	149
6.1(a)	Reference numbers for settlements in Table 6.1	151
6.2	Settlements grouped according to their functional scores (numerical).	154
6.3	Settlements grouped according to their functional scores (logarithmic).	156
6.4	Summary of the hierarchical structure.	157
6.5	The hierarchical grouping of settlements (method 2).	168
6.6	A comparison of two methods of grouping settlements.	171
6.7	The nearest neighbour statistic.	174
6.8	The nearest neighbour statistic (less suburban settlements).	181
7.1	The median range of selected goods at different levels of demand.	209
8.1	The number of towns visited by rural shoppers.	224
8.2	The proportion of shopping journeys made to "premier" and alternative towns.	224

APPENDICES

		Page No.
A.	The full matrix of settlements and functions, with data sources.	253
B.	Village shop types.	257
C.	Bibliography of grouping and classification procedures.	258
D.	Hierarchical grouping - computer program.	260
E.	The questionnaire	262

PREFACE

The aimsof this thesis are fourfold. In general terms they are as follows :-

(1) An examination of the system of central places of a predominantly rural area lying in the counties of Staffordshire, Shropshire and Cheshire, to examine alternative approaches to the problem of ranking centres, and to determine whether a central place hierarchy exists.

(2) A criticism and appraisal of the many published theories on centrality, to assess their validity both in a general sense and in their application to the study area.

(3) To contribute to the analytical techniques available for the study of central place patterns.

(4) To investigate the way in which service centres exert their influence over surrounding rural distiots.

The thesis begins with an outline of the development of classical central place theory, and continues with a critical appraisal of more recent work, for "If we wish to keep on the track... we must first look back of us to see in what direction the track has led". (i) Any responsible research effort must be built from previous work, although in view of Berry and Pred's comprehensive bibliography of 1964 (ii) the present review concentrates on work published since that date.

(i) Hartshorne R. 1939. The Nature of Geography. Ann. Ass. Am. Geog. Vol 29, Nos. 3 and 4.

(ii) Berry B.J.L. and Pred A. 1964 Central Place Studies: a bibliography of theory and applications. Regional Science Research Inst. Philadelphia.

The division of the major part of the text into two sections emphasises the duality of the approach. The first section is concerned with the functional basis of the central place system, it examines the incidence and distribution of selected functions, and derives measures of the absolute and relative functional status of each centre. Settlements are ranked on the basis of their total functional provision, but comparisons are also sought between the separate rankings resulting from the use of retail, service and social criteria.

In the belief that social and service functions, rather than retail development, are particularly significant in recognising rank distinctions among the smaller settlements of a dominantly rural area, these aspects of centrality are given greater attention than they have received from previous workers. The section concludes with an analysis of the techniques for identifying a functional hierarchy of settlements. Such a hierarchy is established for the study area, but it is shown that different hierarchies can be produced by different techniques.

The second section examines the use characteristics of the various centres within the context of centrality studies. The arguement is developed that the use made of a centre by the hinterland population is an alternative approach to the study of central place systems. It is in some senses to be preferred to the classical approaches to ranking, based as they are chiefly on a functional analysis, for it measures centrality directly rather than inferentially. Thus the behavioural patterns of rural consumers and the nature of the rural-urban linkages are measured initially

by means of a questionnaire survey, and the concept of distance-decay in rural-urban affiliations is developed as a possible ranking device. A nodal structure of settlements is identified at various orders, and hinterlands of rural-urban interaction are established and investigated.

Introduction to the study area

The area in which this study was undertaken straddles three county boundaries; in essence it contains the rural west of Staffordshire, the greater part of north Shropshire and much of rural south Cheshire.(i) Together these areas form a considerable rural salient reaching into that system of semi- continuous city regions to which the term "the English Megalopolis" may be applied.

The limits of the area are somewhat arbitrary, but they had to be set within constraints of financial and manpower resources, and the accessibility of the area from the base (The University of Keele). The primary objective of the study was to examine the middle and low order ranks of a central place system in an area lying within a zone of competition and conflict between peripheral higher ranking centres. The latter therefore define the margins. The area thus lies within a ring of substantial towns -i.e. Newcastle-under-Lyme, Crewe, Shrewsbury, and Stafford, and these must clearly be included for purposes of functional and hinterland analysis. More distantly even higher order centres flank the study area, e.g. Wolverhampton, Hanley, Birmingham and Manchester, but no attempt was made to include these in the analysis.

(i) The administrative districts of Shrewsbury M.B., the urban districts of Newport, Wellington, Whitchurch, Wem, Market Drayton, the rural districts of Wellington, Wem, Drayton, the parishes of Ashley, Albrighton, Uffington, Upton Magna, Withington, Shifnal, Sherrifhales, Tong, Stafford M.B., Newcastle M.B., Stone U.D., the rural districts of Stone, Stafford and Newcastle, that part of Cannock R.D. which lies north of the A.5 trunk road, Crewe M.B., Nantwich U.D. and Nantwich R.D.

The area thus defined was a mainly rural one in which primary and tertiary occupations dominated, and which afforded examples of a broad range of service centres, from substantial county towns down the scale to very minor settlements. This was also an area in which the central place system had not previously been examined.

The administrative divisions of the study area are depicted in Figure 1 as they existed in 1961. Although subsequently several of the smaller towns have been amalgamated with their surrounding rural districts to form larger units, the map is presented thus to indicate the areas for which data was collected in the 1961 census. In all the area is some 55 x 55 kms., covering 225,000 hectares and occupied by 450,000 people.

The district occupies part of a Triassic basin between the Potteries and North Wales coalfields, or in a wider context between the Pennine and Clwydian/Berwyn uplands. Keuper Marls fill much of the trough, but occasionally upfaulted outcrops of Bunter sandstone form low (max. 200 metres) plateau-like hills. The details of the landscape are mostly of glacial origin, and extensive belts of boulder clay, sands and gravels blanket the district. The whole area is well drained by the rivers Weaver, Severn and Trent, and their tributaries, although locally the lack of slopes and heavy soils can impede drainage.

Here then is a gently undulating landscape with occasional sandstone hills which is well drained and which has a fairly uniform precipitation of just below 30 inches per year. Against this physical background the type of agriculture practised varies little. The main agent of variation is the soil. Most of the area is covered with gley soils and brown earths, giving rise to the extensive high quality pasture although arable land increases in importance on the higher soils of the drift free areas, and the sandstone hills are frequently crowned by deciduous woodland.

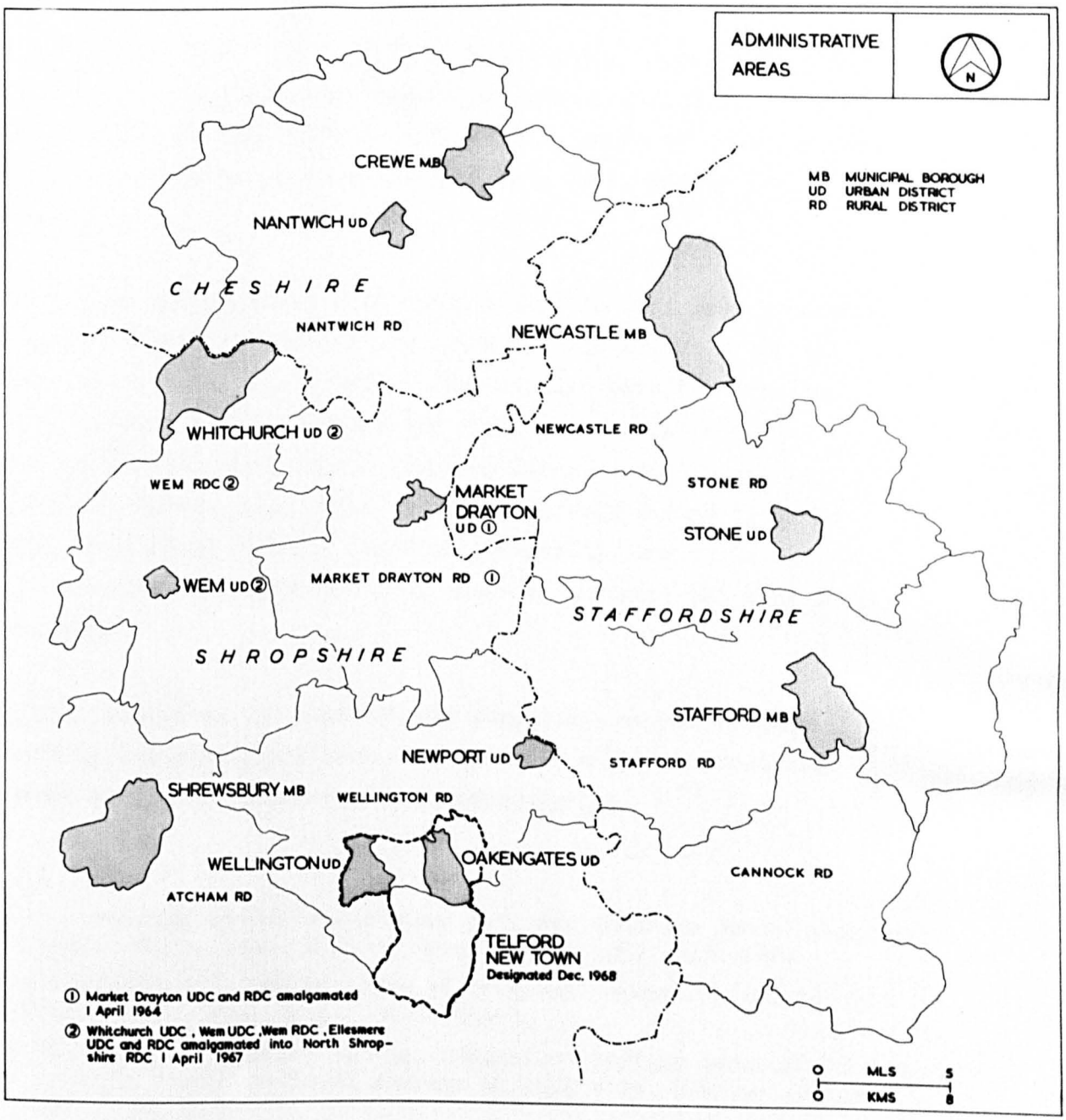

Figure 1 The administrative divisions of the study area

Everywhere there is an emphasis on livestock, especially dairy cattle [(i)] and self-contained farms with specialised dairy herds are typical. Most of these farms grow a certain amount of wheat or oats, although in all three counties small pockets of intensive arable cultivation exist.

The high proportion of good quality land in this part of England is largely responsible for the consistently high prices which the land fetches both to rent and to buy [(ii)] but it also permits very high stocking ratios. [(iii)] Cheshire and Staffordshire in fact have a greater density of dairy cattle than any other county in Britain. All of these factors contribute to an intensively farmed livestock economy, with a high overall level of prosperity, and it is against this socio-economic background that consumer movement patterns were investigated.

Rural settlement patterns at any stage in time are frequently obscured by subsequent patterns, but detailed analysis shows that different stages of colonisation are recognisable. [(iv)]

(i) For a detailed survey see Simpson E.S. The Cheshire Grass-Dairying Region. Trans. Inst. British Geog. No 23 1957 -p141-162.

(ii) See Grigg D.B. 1965 An index of regional change in English farming Trans. Inst. Brit. Geog. 36 p. 55-67.

(iii) 1955 Density of dairy cattle. Cheshire 270/1000 acres, Staffordshire 207/1000 acre, National Average 98/1000 acre. Source: Simpson 1957. Op. Cit.

(iv) For instance Sylvester D. 1969 The rural landscape of the Welsh borderlands. Macmillan.

Particularly in the north and west of the study area, in Cheshire and north Shropshire there is strong evidence of considerable Celtic settlements. Celtic/Welsh place names are frequent indicators but elevated church sites as at Barthomley, Wrenbury and Marbury also suggest pre-Anglian settlement. At this stage large or nucleated villages would have been rare and a pattern of scattered hamlets and farmsteads developed. Subsequently, the evidence of — ingham, —ton and —bury (burh) place names points strongly to the emergence of more nucleated Anglian villages, and many of these today form the basis of the pattern of central places of low order.

Norman times brought an increase in commerce and a period of relative prosperity. This was especially important in Shropshire and Staffordshire where it prompted an increase in the number of churches and markets, and stimulated the further development of nucleated villages. Norman settlement developed in Cheshire was mainly in the form of park estates, or the seigneurial boroughs from which most of south Cheshire's present towns have developed.

From late medieval times to the mid 18th century little new development occurred in the settlement pattern, but the enclosure of common lands (Cheshire 1765-1898) provided the stimulus for the growth of many small hamlets, e.g. Prees Heath, Hine Heath, Poynton Green. Sylvester (i) suggests that the enclosure of commons, the

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(i) Sylvester D. 1969 Op Cit.

turnpiking of roads, the increasing prosperity of agriculture and the spread of nonconformist chapels spattered the countryside with dispersed dwellings and hamlets.

Sizeable villages are rare and widely spaced in Shropshire and Cheshire, and dispersed hamlets and farmsteads constitute much of the settlement pattern, although this is not true of Staffordshire. In the former area the multi-township parish, where a parochial village is surrounded by many satellite hamlets is common (e.g. Wynbunbury, where the 1840 parish embraced 18 satellite townships and Wem with 10.)

More recent population growth and settlement patterns in the area have been largely in response to economic factors. Industrial development is concentrated in a crescentic band from Crewe (i) through the Potteries down the axis of the Trent valley to Stafford, and then intermittently westward taking in the Telford New Town area and terminating at Shrewsbury. This leaves a large rural heartland where employment is almost wholly in services and agriculture, (e.g. Drayton R.D.C., 40.5 percent of economically active males are in agriculture. Wem R.D.C. , 36.1 percent).

The recent population changes in the area are also closely linked to this crescent of economic opportunity. The main population increases have been in the south and east, while the central, northern and western districts have experienced a decline. All of the population increases between 1951-61 occurred in, or close to the major urban areas. Stafford, Shrewsbury, Wellington and Nantwich

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(i) which until its selection as a main railway junction in 1842 was a small agricultural hamlet known as Monks Coppenhall.

all gained substantially, but the decade also saw large increases in the parishes most conveniently located for daily commuting journeys into the main employment centres. In the central rural area widespread population decline has prevailed, though the small market towns all show very modest increase.

The growth of industrial populations and manufacturing towns has therefore been far more localised than the earlier development of settlements. The inner edge of the crescent represents an advancing suburban frontier, the effect of which upon the pattern of central places will be discussed in a later section.

This preface has served as an introduction to the scope and content of the study, as well as outlining the nature of the area under examination. It has been necessary to review the physical, agricultural and historical features of the area, for they are the framework upon which a system of central places has developed. The specific objectives of the study have been outlined, but the thesis as a whole has an additional, secondary purpose. Through exploration of the complex linkages which exist between service centres and their surrounding rural district it is hoped that this study will contribute towards an understanding of one of the most challenging problems facing today's planners; that is the integration of town and country.

Chapter I - An outline of central place theory and a review of the conceptual models.

In the thirty-five years since Christaller published "Die Zentralen Orte in Suddeutschland" Central Place Theory and the associated problems of ranking towns as service centres within an urban hierarchy have come to occupy an important position in the study of Urban Geography. Nor is this interest purely academic, for with the increasing need to plan for the orderly growth of towns their functional status must be examined in the regional context of the urban hierarchy. No town can stand completely independently, or isolated from its neighbours and the complex patterns of social and economic interaction between town and country, and between one town and another engage the interest of the Planner as much as the Central Place Theorist. Many workers suggest that these social and economic patterns are faithfully reflected in the geographical spacing of settlement foci, and that a degree of geometrical regularity can be identified such that Central Place Theory provides a genuine rationalisation of the distribution of urban populations. This indeed was an essential premise of Christaller's work but its application to more densely populated and highly industrialised countries such as Britain seems both uncertain and limited.

It is the intention of this chapter to outline the development of Central Place Theory from Christaller to the present time. While the writer does not necessarily believe that W. Christaller was the earliest worker in this field (1) it does seem that Die Zentralen Orte in Suddeutschland (1933) was the inspiration from which much subsequent work has stemmed.

(1.) See for example H. Bobeck: Grundfragen der Stadt Geographie Geographischer Anzeiger 1927 p.213.

In order to review the immense amount of work on Central Place Theory and the urban hierarchy in some means other than through simple chronological account, a classification is necessary. Any such system of classification must to some extent be arbitrary but the one below is suggested on the grounds of simplicity and completeness. Inherent in this grouping is the recognition that two main streams of thought are evolving side by side: on the one hand the theoretical approaches and on the other the empirical studies. It should not be thought however that the two are totally divorced for many workers, (e.g. Christaller himself) illustrate their theory by applying it to a specific area.

I THEORETICAL

1. The Urban Mesh as a geometrical pattern. To this group belong those workers such as Christaller and Losch who looked at the urban mesh in terms of geometrical patterns and locational economics.

2. The testers of the above ideas and the model makers such as Dacey, Morril and Thomas.

II EMPIRICAL STUDIES

1. The Urban Approach. Under this heading appear the various studies which examine the urban settlements: they are largely outward looking studies, and can be subdivided as follows
   (a) the identification of key services and associations of services
   (b) analyses of the summation of all services and functions of the centre
   (c) analyses of selected urban data — e.g. consideration of retail turnover in relation to population.
2. The Hinterland Approach — or the analysis of the linkages between town and country or between towns. These are

essentially inward looking approaches and can be divided into two groups.

(a) those which measure the accessibility of different centres largely by analysis of public transport services

(b) those which measure the attraction of central places in terms of the actual use made of competing centres by the surrounding population.

THEORETICAL STUDIES

1. The Christaller Model and its theoretical principles.

Christaller[1] recognises the pioneer works of Weber[2] and Von Thunen[3] but his own work on the geographic, economic, social and political components of the urban/economic system has provided the take off point for most subsequent central place study. Christaller's ideas are based mainly upon economic principles and to some extent he recognises and regrets that there are many geographical and historical criteria which have been omitted. He considers that economic factors are decisive in the location of towns and rural settlements and suggests that the raison d'etre of most towns is that of a functional centre for a surrounding rural area. Centrality in this context refers less to the locational position than to the central nature of the services provided. Each central place will have a hinterland of its own for which it acts as a collection point to which it supplies or distributes goods not produced by the rural economy. Clearly not all centres can offer all goods and services.

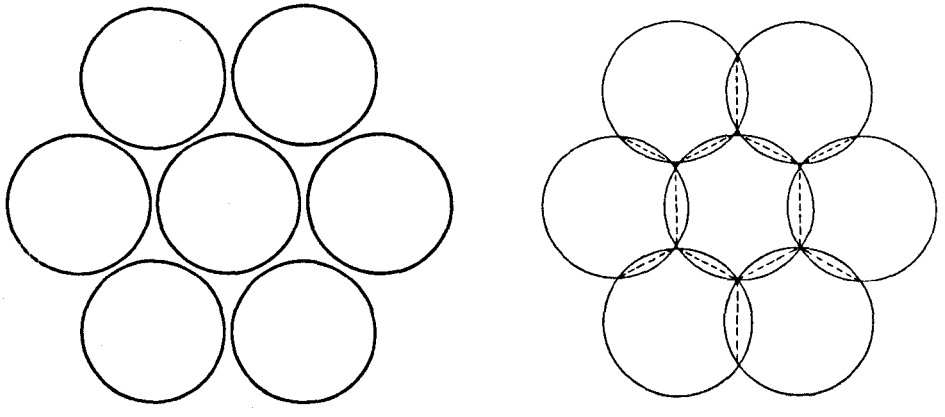
Christaller discusses the range over which a good or service may be distributed (in this example the services of a doctor) in terms of price-willingness of the surrounding population to purchase. He shows that in some cases an increased supply of a good at an auxillary central place can stimulate increased demand in that a greater proportion of the district's population will now be close to the distribution point and that consequently less effort will be required for purchase of the good.

In short Christaller was seeking a group of laws which would bring order to the seemingly arbitrary distribution of urban services and to the apparently individually determined sizes of settlement foci. Working from commercial principles he evolved a spatial pattern and a graded order of service centres with circular trade areas. In order that these areas would fit together in a network leaving no unserved interstices the circles were modified to hexagons fig 1.1.

The mathematical relationships between the numbers of centres of various ranks and sizes are summarised by the following arrangement of an L-System. The letters represent towns of diminishing rank and size from L (the largest and most fully equipped as a service centre) to M (the smallest and least fully equipped).

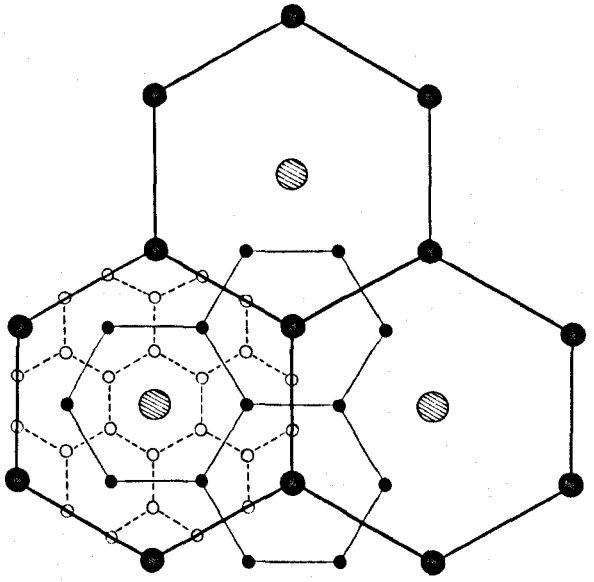
1L; 2P; 6G; 18B; 54K; 162A; 486M.

Each rank contains three times as many representatives as the one above it. Fig.1.1 shows how each lower-level centre is located at the midpoint of three higher-order centres and how each higher order centres is surrounded by a ring of six lower order centres situated at the points of its hexagon. The figure also shows that the progression of trading areas in the same system is 1:3:9:27:81 ..... i.e. a series which also progresses by a factor of three. This has been called by Lösch and others a



(a) (b)

Circles to represent market areas (a) Clustered (b) Ovelapping to form hexagons



A hierarchy of centres with hexagonal trade areas according to Christaller's marketing principle.

Figure 1.1 The theoretical pattern of trade areas (after Christaller)

K=3 network.

Each of these centres has a dependent and tributary region. The M-place for instance has a region of theoretical radius 4km. The A place has two regions which are superimposed: one in respect of M goods and of radius 4km and one for A goods with radius = 7km. Likewise for the K-place the regions are, an M region of r = 4km, an A-region of r= 7km and a K region of r = 12km. Herein lies the principle of the nesting of service areas by which a town supplies goods appropriate to its individual degree of specialisation but also those goods of orders lower down the scale. The complete scheme in an L-system is as follows :

	Grade of Town:	Approx. Pop'n.	Radius of Region. Km.	Area of Service Region. sq.km.
I	Marktort M	1,000	4.0	44
II	Amstort A	2,000	6.9	133
III	Kreisstadt K	4,000	12.0	400
IV	Bezirkstadt B	10,000	20.7	1,200
V	Gaustadt G	30,000	36.0	3,600
VI	Provinzstadt P	100,000	62.1	10,800
VII	Landstadt L	500,000	108.	32,400

In addition to economic factors Christaller examines traffic networks and their effects upon the pattern of central places. He suggested that this tends to distort the previously noted pattern; dominance of traffic factors will lead to the development of a larger number of centres than the minimum required by the marketing principle and the trade areas will often lose their hexagonal regularity. A third kind of organisation is the socio-political one based on a town's importance as an administrative centre. This may also distort

the theoretical pattern since towns with high administrative rank — perhaps as a result of a historical accident — will possess a commercial advantage. A dominating influence of the administrative pattern on the urban framework is more likely in federal situations such as Germany, but it is stunted in centralised states such as France. In the competition of the three principles discussed, one does not necessarily triumph.

The above factors are largely static ones; they are momentary abstractions from an ever changing set of processes. Christaller is aware of this and he enumerates various continually changing economic aspects and their effects upon the central place patterns.

One of the more important dynamic processes is the growth of population which is accompanied by an increasing demand for services and the development of auxillary central places. If a region's population grows evenly in town and country then a new service centre will develop at a point as far away as possible from the old established central places. If however all of the population growth takes place in one large town, no new central place will form. Any inequality in the distribution of population growth will distort the theoretical pattern. Christaller also discussed the effects of technical progress and production costs upon the central place network. As a result of changes in any of the above factors concomitant changes can occur in the distances between central places, in the typical sizes of central places, or in the location and number of central places.

Although concerned primarily with economic factors, Christaller indicates various geographical features such as variations in soil, climate or physical landscape which can

seriously distort the ideal pattern.

In part 2 of Die Zentralen Orte in Suddeutschland the problems of determining the rank of central places and their characteristic functions is discussed. The following nine groups of functions are cited as diagnostic.

1. Adminstrative: e.g. local government, police and law courts.
2. Cultural and Religious: schools, churches and libraries.
3. Health: doctors; dentists, hospitals and vets.
4. Social: cinemas; newspapers, theatres, sports stadia, etc.
5. Economic and Social: guilds, Co-Ops, Chambers of Commerce.
6. Commercial and Financial: retail shops, warehouses, markets banks.
7. Utilities: gas electricity, garages.
8. Importance as a Labour Market
9. Transport and Communications: stations, G.P.O.s telephone Headquarters.

The idea of adding all of these functions together with suitable weightings for their relative importance, to gain a measure of a town's importance is dismissed as inadequate. At this point Christaller indentifies what is still one of the main shortcomings of Central Place study and that is the absence of a satisfactory method by which the total importance of a town as a service centre may be expressed. Christaller chose to analyse the distribution of telephones and he stated "one need only to count the number of telephone connections; the number coincides rather exactly to the importance of a place."[4]. After the elimination of localised errors the following formula for the specific importance of a place is obtained.

$$SB_z = T_z\left(\frac{E_g}{40T_g}\right)$$

where SB_z = specific importance

T_z = No. of telephone connections at that place

$\frac{E_g}{40T_g}$ = a reduction coefficient found by relating $\frac{E_g}{Tg} = \frac{\text{No. of inhabitants in region}}{\text{No. of telephones in region}}$

to the normal ratio of inhabitants to telephones which was 40:1 in S. Germany.

This formula was refined by Christaller to give the importance surplus (Z_z) ot a town, a far more accurate measure of centrality.

$$Z_z = T_z - E_z\left(\frac{Tg}{Eg}\right)$$

T_z = No. of telephones in town

E_z = population of town

T_g = No. of telephones in region

E_g = population of region

The theoretical pattern of settlements derived by this central place theory was found to correspond closely with real conditions in Southern Germany. Furthermore, the use of the formula based on telephone connections faithfully reflected the importance and relative ranking of the centres examined, but the system was upset by local factors such as industrial concentration or main transport routes.

Before proceeding to an examination of the enormous and varied body of work which has suceeded the publication of Die Zentralen Orte in Suddeutschland (and largely derives from it) a critical appraisal of Christaller's work must be attempted. It should however be noted that the author was aware of some of the shortcomings of his work.

The first criticism is that mooted by Bobek [5] who points out that two-thirds of the population of Britain and Germany live in cities, many of which are essentially industrial and that only one-third of these cities are true central places in owing their growth to the importance of their regional functions. It may be argued that Christaller's choice of Southern Germany as an area for study was somewhat subjective and that the area can be seen from a cursory examination to lend itself well to this kind of study. It is a serious fault that the method cannot be readily adapted for use in an area with an entirely different population distribution and economic system; in particular it fails in the congested urban and industrial regions in which an increasing proportion of the world's population lives.

No allowance is made in this system for hinterlands which overlap although it can clearly be seen that this is a feature which prevails almost universally. Nor does it take account of the effects of proximity to a metropolis which commonly results in the repression of smaller centres. The proximity of Augsburg to Munich is mentioned in this respect, but only briefly. Moreover the system proposed is not sufficiently flexible to account for differing regional population densities, or the variations in demand which are imposed by different socio-economic groups. Christaller mentions, but fails to incorporate historical factors and the momentum of long established centres.

Little Central Place study followed in the 1930s and the impact of the war probably delayed scholarly reaction to Christaller's book. The late 1940s and the 1950s saw a great increase of interest in central place study and reaction to

Christaller's work found its clearest expression at the International Geographical Union Symposium at Lund in 1960. Many workers criticised Christaller's theories on the grounds that they were designed to operate in ideal conditions, within a geographical vacuum with a uniform economic structure and an even population distribution. Much of this criticism is summarised later in specific references to Lund papers but it should also be noted here that some of the critics missed the point by their failure to recognise that Christaller's system is not an explanation for the location of urban settlements in general. He concerns himself specifically with the tertiary services and market orientated commodities, and his theory therefore concerns the location of centres with dominantly tertiary functions.

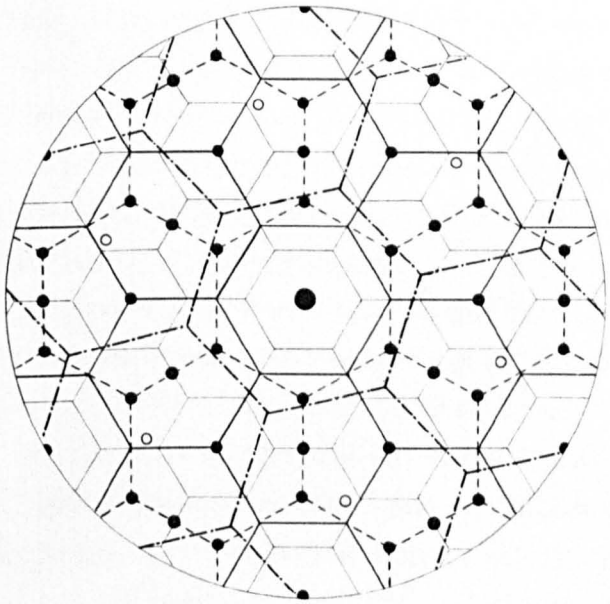
A second major contribution to Central Place theory is that of A Losch[6] who also examined the arrangement of trade centres from an economic viewpoint. He is concerned largely with the balance between two sets of forces: the forces tending (by economies of scale) to concentrate production in a relatively small number of locations, and the forces of decentralisation which minimise distances and transport costs. There is some analogy with Christaller's work in that similar ideal conditions are assumed, but great difference in that where Christaller laid out his metropolitan centres first, Losch built his system from the lowest order good upwards.

The Loschian economic landscape also postulates hexagonal service areas as the basic unit but for each commodity the areas will vary in size so various hexagonal networks are allowed to coexist. By superimposing all of the hexagonal lattices on

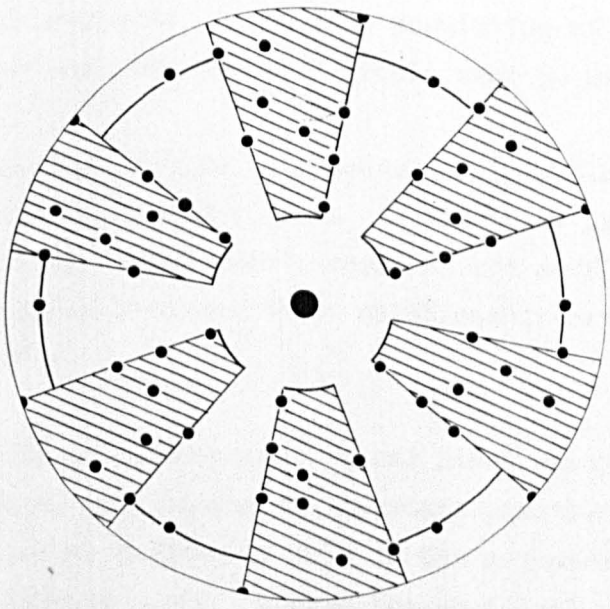
a single point and rotating the nets about that point Losch obtained six sectors with many centres, and six sectors with few. fig 1.2. With this arrangement all nets have a centre in common (which will develop as the metrolpolis), the greatest number of locations coincide and the transport lines are reduced to a minimum. In contrast to Christaller's hierarchy which consists of a number of definite ranks of settlement sizes, that of Losch is far less rigid and consists of a nearly continuous sequence of centres. Centres in this economic landscape become specialised and settlements of the same size do not necessarily perform the same function; moreover larger places do not necessarily have all of the functions of smaller settlements. There is no constant ratio between the various sizes of hexagonal service areas so they do not 'nest' in the manner proposed by Christaller.

The basic difference in the two approaches can be summarised as the difference between a fixed-k hierarchy and a variable-k hierarchy. That is to say that while Christaller saw a constant ratio between the number of settlements of each rank and also between the various sizes of trade areas, Losch saw this fixed-k assumption as a limiting case and recognised no such relationship. In comparison the methods are both deterministic and both represent the locational patterns in algebraic terms. Losch's system is considerably more complicated and less easy to analyse, but it also appears to be more in accord with reality than that of Christaller.

This outline of the work of Christaller and Losch sets the scene for the more recent studies, particularly those which have sought to test and modify the Christaller model.



The theoretical pattern of an economic landscape after A. Lösch



The theoretical economic landscape with hexagonal networks rotated about the central metropolis to produce sectors alternately rich and poor in locations.

Figure 1.2 The theoretical economic landscape (after Lösch)

I. 2. The testers of Christaller's Model.

Among the more prominent recent theoretical workers who have sought to test and modify Christaller's system of central places is Edwin Thomas[7] who treats the spacing of cities as an interdeterminate stochastic model with two requirements :-
(1.) completeness, i.e. it must account for all eventualities;
(2.) relationships must be fairly stable over a period of time, although in conclusion Thomas tends to forget this condition. His basic contention has been pointed out by Christaller and others, that pairs of large cities are further apart than pairs of small ones. In considering groups of towns Thomas frequently uses the phrase "same population size" and he follows Hald[8] in defining this in terms of a permitted margin of difference.

By applying probability concepts to actual examples from the State of Iowa, Thomas shows that the relationship between the population of a sample city and the distance of that city from its nearest neighbour of the same population size is statically significant and appeared stable over 50 years.

Although incomplete this is a useful contribution to literature on the spacing of cities. In effect it is a natural extension of much of Christaller's research and adds quantitative weight to the idea of a discernible relationship between city size and separation.

In any review of theoretical central place study the work of Michael F. Dacey must occupy an important position, though many of his ideas are accessible only to the mathematician. In one of several studies Dacey [9] choses the empirical work of Brush[10] in Wisconsin as a suitable platform from which to analyse central place patterns, in particular the hexagonal principle,

In the pattern of minor central places in Wisconsin postulated by Brush, a hexagonal lattice is implied but not demonstrated. Dacey takes the central place pattern as a point pattern and tests it for form: he suggests that where there is absence of a systematic pattern the distribution of points is random. A non-random distribution is either "more clustered than random" or "more uniform than random". The nearest neighbour method is used to measure the degree of deviation from random of a point distribution. In a suspected hexagonal lattice this means that each point will be equidistant from six other points and it is necessary to evaluate these points in order to identify the hexagon. A refined nearest neighbour method is outlined by Dacey and applied to the example above of S. W. Winconsin. He finds that the central places do not conform to a hexagonal lattice distribution and that they are in fact scattered randomly. Central place theory as a whole is not rejected as it is not fully examined.(i)

Simulation models are used as a technique for central place study by Morrill[11.] who attempts to simulate patterns in a temporal frame and his probabilistic approach contrasts strongly with the deterministic ideas of Christaller. He is concerned with explaining a general pattern of settlement, not with the exact location of centres, and he takes into account the fact that different places are at different stages of growth at any given point in time. Morrill uses a Monte Carlo model in which random irregularities are considered and where behaviour is governed by a set of probabilities. No unique mathematical solution is possible by this method, but it does provide a

(i) Dacey takes the classical hexagonal lattice as a framework and brings this pattern nearer to reality by assuming that the lattice is an equilibrium state and that actual locations of central places are stochastic displacements.

procedure for evaluating different cases. One point which is made succinctly in this work is that although locations are largely static, populations are dynamic, that is, they may be increasing or decreasing. This may lead to a hinterland temporarily being too large or too small for the central place to which it belongs. Morrill's work also suggests that one of the main problems for the future lies not so much im improving the mathematics of Central Place Study as in identifying and isolating the most realistic set of laws.

In a work entitled "Theoretical Geography",[12] William Bunge lucidly discusses many of the theoretical tenets of Central Place Study. Dimensional analysis and Location Theory are the main tools with which Bunge shapes his own contributions to Central Place theory and in these terms he analyses spatial aspects of the economy and settlement pattern.

Much of the contemporary theoretical content of Central Place study stems from the work of Berry and Garrison in 1958.[13] The concepts proposed by these, and other associated workers have been largely drawn together and summarised by Berry[14] so their discussion here will be fairly brief. In 1958 two concepts were used to develop the central place system. These became known as threshold (i.e. the minimum population which would support the entry of a good) and range (i.e. the maximum distance consumers are willing to travel to a centre). Herein lies a fundamental weakness of Berry's argument for he perpetuated traditional economic theory in assuming that consumers will travel to the nearest centre that provides the good or service they require. Subsequently these concepts are consolidated [15] and presented as a set of equations. "The equations empirically

derived, but theoretically meaningful, reveal that both a continuum of places and a classic central place hierarchy are to be found in any region."[16] In Snohomish county, Washington a hierarchical class system of settlements was identified where each class possessed specific groups of central functions and was characterised by a discrete population level. Sixty-three central functions were identified and of these, 52 were described as variates; that is the number of outlets performing these functions varied from place to place. The other functions were described as attributes, a centre either possessed them or it did not. Analysis revealed that when these functions were ranked by their threshold levels three groups could be identified. Correspondingly three groups of central places were distinguished, and tentatively labelled hamlets, villages and towns.

Berry finds a link between Central Place studies and general systems theory and Olssen [17] relates Central Place systems to the more general theory of spatial human interaction. Olssen suggests that the use of scientific models may be limited by the inevitable neglect of many important factors in the processes of developing a workable model from formal theory. In spite of these difficulties it is suggested that since the behaviouristic assumptions upon which most of the deterministic Central Place Models are based are clearly unrealistic, simulation models may offer the best means of approach.

A useful link between the preceding theoretical formulations and the outline of more pragmatic approaches which follows is provided by L. King [18] who attempts to identify the real factors which account for city size and distribution. Selected social, economic and physical variables are tested for their

correlation with the distance of separation of 200 randomly selected American cities. Total population density was the single factor which accounted most significantly for the separation, but physical features were also found to be important.

In the first part of this chapter we have seen how Central Place Theory has evolved from principles enuciated by economists, into a model intended to explain geographical realities. In recent decades the new tools of the behavioural and locational sciences and the techniques of regional science have made valuable contributions, but this review illustrates the inconclusive position of Central Place theory today. Central Place Theory is a consuming academic problem which occupies a focal position in the content of Theoretical Geography and it also has important practical applications for planning purposes. For these reasons Central Place study will doubtless continue to attract much interest, and it is possible that with the development of new, high capacity computers capable of handling the immense number of variables concerned many of the problems may be resolved.

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Chapter 2 — A critical discussion of empirical approaches to central place study.

A totally different approach to the geography of Central Places has found greater popularity in this country; this is essentially an empirical group of methods of investigating the urban hierarchy. All methods discussed in this group are pragmatic and experimental approaches and all are concerned with investigations of actual settlement patterns. In essence these methods consider the centres per se and seek to rank them and analyse their functions without a primary concern for their regional relationships or hinterland linkages. The three main groups utilizing an urban approach are outlined on page 2 and will now be examined in greater detail.

II 1. THE URBAN APPROACH

(a) The Identification of key services

The approaches involving an identification of key services and logically derived associations have developed largely from initial works by Dickinson[1] and Smailes[2].

Chronologically R.E. Dickinson's study of the smaller urban settlements of East Anglia is the first major work in this field, but in common with many later works it suffers from being subjective and largely intuitive. Without doubt it is possible to recognise a ranking of urban settlements which embraces such divisions as "Towns", "minor cities" and "major cities", but neither Dickenson nor Smailes put forward any concrete or entirely objective parameters for these classes. Dickenson recognises these difficulties — he identifies an urban settlement in a rural area as a focus of human life

and activity and of commercial, industrial and cultural functions but agrees that it is difficult to distinguish between a town and a village on functional grounds.

Dickinson's hierarchy may be cited as an example of the arbitrary nature of much of this early work, viz:

(i) Rural villages — mainly agricultural but with a small proportion of the inhabitants providing non-agricultural services.

(ii) Urban villages with higher functional status. A large proportion of the population is engaged in retail trades and handicrafts -e.g. plumbers, saddlers, drapers, chemists etc.

Towns are distinguished by a greater number and variety of services and by specific facilities such as schools, solicitors and banks.

In one of the more widely known studies of this nature Smailes [3] ranks the towns of England and Wales according to their possession of widely applicable key factors. In addition there are identified trait complexes, or associations of these factors which, it is suggested, are particularly diagnostic. Having identified urban characteristics such as secondary schools, hospitals and cinemas, Smailes ranks towns into groups according to their scale of equipment in these functions. The range thus identified is an overall urban hierarchy as distinct from a Central Place hierarchy and many of the criteria chosen are no longer valid.

In a study of shopping centres in London Smailes and Hartley [4] carry the analysis of urban equipment a stage further, into the hierarchy of service centres within the conurbation. It is suggested that since shorter distances are involved, and

public transport is superior in urban areas some of the advantages of concentrating functions at one spot no longer hold. For example there is no real disadvantage in locating hospitals and schools away from the main shopping foci. The key functions chosen in this study frequently show anomolies in their occurence and it could almost be suggested that the divisions between groups in the hierarchy have been chosen intuitively and the centres fitted in afterwards. One of the advantages of choosing a few, significant indices is that this cuts down the data to be handled and permits consideration of large areas.

Carruthers [5] subsequently refined this methodology by incorporating a measure of the intensity with which facilities were used. Rateable values were suggested as a measure of the intensity of the use made of a centre by shoppers, but a bus service analysis proved more useful. Each centre in the conurbation was graded according to the nodality of its public transport system and according to the number of incoming buses per hour. A points system was devised whereby each centre achieved a score according to (1) its shopping provision, (2) its rateable value and (3) its incoming bus traffic. Although inherent in this is the assumption of a linear relationship between centres of successive orders.

Carruthers continues by giving brief consideration to the changing status of various centres but this aspect is pursued more comprehensively by Smith.[6] Smith compares Smailes 1938 data (which he admits to be insensitive) with

equivalent information for 1965 and concludes that centres of all types were remarkably stable in their distribution and relative status over this time period. He observes that if regional population is static or declining, any advantages are gained by the larger centres, but that in areas of considerable population growth a new range of minor or convenience centres are generated.

Other works which are based upon the selection of key indices include those of Duncan J.S.[7] in New Zealand and Boustdet[8] who examined the significance of bus indices by means of a dispersion factor. The ease of application of this general method is illustrated by its use in a recent survey into the proposal to build a regional shopping centre at Haydock Park in Lancashire.[9] An assessment was made of the hinterlands and status of shopping centres in a large area of N.W. England, the West Midlands and Wales by means of the following diagnostic criteria:

A. Specific Indices; Department Stores
Variety Stores
Theatres and Cinemas
Grade I Markets (i.e. 10,000 sq. yards floor space).

B. General Indices; Banks
Chain Stores
Markets - Grades I and II
Building Societies.

Group A includes those factors which play a major role in attracting people to the shopping centre and Group B includes shops and offices selectively chosen to typify the sum total of indices present. From the graph the centres were ranked into five groups ranging from Manchester and Liverpool in Group I down to quite minor suburban and rural shopping localities. As noted with other similar methods there is a

lack of completely objective rules in the ranking process and it is hard to justify the breaks in the graph which have been chosen as group boundaries.

Most of the methods discussed in this section attempt to give a qualitative measure of the status of central places, but the apparently arbitrary manner in which the hierarchical groups are chosen and delimited must inevitably lead to criticism. In the face of more sophisticated and quantitative work this method ofspecific indices may appear to be almost naive,but it can be argued that it is based upon the thoughtful sifting of actual survey results and is very much in touch with real conditions. The absence of exact numerical data and lack of rigorous statistical treatment is not necessarily a shortcoming but it seems increasingly likely that quantitative methods will lend themselves more readily to universal application.

(b) Analyses of the summation of all Central Functions.

The second approach to the study of the settlement node as a Central Place is that which considers, or sums all of the central functions. Sometimes this is a relatively crude addition of all retail and service outlets but various refinements are possible in terms of the size of establishment, or the intensity with which it is used.

The names of B.J. Berry [10] and his associates are closely linked with this kind of study but their observations are largely theoretical (but based on empirical research) and so

have been discussed in an earlier section.

Peter Scott [11] has analysed the urban hierarchy of Tasmania and in the absence of satisfactory weighting factors it is accepted that a summation of central functions will be sufficiently accurate. In some respects the resulting technique is a compromise between that of Smailes and the more sophisticated methods of Berry. Scott records the total functions of each nucleated settlement having at least two functions and identifies four groups.

To differentiate the classes, the relationship between the numbers of functions and the number of functional units (or occurences of these functions) was examined by means of a log linear graph. This pattern revealed three breaks of slope and four regimes. Three of these regimes were called hamlets, villages and towns respectively and the fourth contained only the towns of Devonport and Burnie. It was suggested that these latter could be designated cities, but major towns would be more realistic.

Each group is held to contain a discrete range of functions and those functions common to at least 75 per cent of centres within a group are called typical functions. As an example 171 villages were defined and these were typified only by post offices, telephone exchanges and general stores.

A recent example of more exact and sophisticated work along these general lines is that done by W.K. Davies [12] in South Wales. Davies makes use of Location Coefficients to give a measure of the focality of urban functions. In considering retail establishments to which Davies largely

confines his interest, the location coefficient can be expressed as

$$C = \frac{t}{T} 100$$

where C = Location Coefficient
t = one outlet
T = Total Number of outlets.

In short he ranks functions by their rarity of occurence in the study area.

Forty-nine functional types are identified and for each function the multiplication of the location coefficient by the number of outlets in each centre results in the centrality value given to that centre by that function. The addition of all the centrality values for one place gives its functional index. An array of centrality values was constructed to include all of the central places ranked according to their functional indices,and the degree of similarity between adjacent pairs was determined by Spearman coefficients of association.

In this way five groups of settlements are confirmed. Naturally groups were not functionally identical but the variations in complexity within any individual group were not sufficient to destroy the overall hierarchical pattern. In common with most other workers Davies found that centres of each higher order perform all the functions of lower order centres as well as those endemic to their own rank.

The frequency of occurence of establishments in the study area ranged from grocers, of which there were 221 and ladies clothes shops (185) to photographic dealers (3) and shops selling surgical and health goods (1 only). He

establishes that distinct rank groups do occur and that on the basis of functional provision members of any one grade are sufficiently alike to be distinguished from any other group.

The method is valuable in that it is capable of widespread application but it is questionable whether the groups of settlements identified in S. Wales will be comparable with those found elsewhere. It is a serious criticism that Davies has assumed a closed system of self-contained service provision —this may well be adequate for investigating a confined Welsh valley, or within the sphere of influence of one major central place but it would be difficult to justify in other circumstances. The small area chosen for study underlines the immense amount of labour which would be required in a larger district.

In perspective it would seem that the approaches outlined above which consider all of the functions provided at a settlement focus offer useful tools for further Central Place study. It is however possible that these methods could confuse the precise meaning of centrality and they are not always accurate in their representation of the centrality of towns in their regional context. On the other hand these methods lend themselves admirably to quantification and to statistical analysis, and results can usually be presented precisely and succinctly.

(c) Selective urban approaches

There is a school of workers, who have looked at central place ranking from a more selective view. This often involves consideration of one specific feature such as the retail structure or turnover. Frequently there is no attempt to distinguish different types of shops or services; and in considering work of this type we should remind ourselves that a "retail centre" is not necessarily the same thing as a central place.

In 1954 Fleming [13] made a study of retail trade of the whole of Sotland. This was designed to provide a basis for comparison between one town and another but in the process a crude hierarchical ranking emerged. Previous surveys relying on a simple count of shops were dismissed as inaccurate by Fleming who makes use of the 1951 Census of Distribution to ascertain annual retail sales per capita for each Burgh with a population exceeding 2,500. By incorporating the population of a town"s bus-service hinterland it was calculated that annual sales per person ranged in 1950 from £20 to £180. The correlation between total sales and total population of town and hinterland for all Scottish centres was 0.98. Fleming's article illustrates the potential of the census of distribution for this kind of work but unfortunately it has limitations. Not the least of these is the fact that for towns below 50,000 population the total retail trade for the local authority area is not distinguished from the central area trade. Towns with populations below 25,000 are not tabulated in any detail.

Another interesting study in the 1950's was that of P.A. Brown [14] in the East Midlands. Brown's main tool is again per capita retail turnover and he suggests that there are three determinants of total trade of a town :

i. the size of population served
ii. range and attractiveness of facilities
iii. regional variations in spending power.

Knowledge of retail turnover in a town and the regional per capita expenditure permits calculation of the expected hinterland population of that town. In this respect Brown found close correlation with the hinterlands of the Ordnance Survey

1/625,000 Local Acessibility Map.

For the East Midlands area the per capita sales for each town are assigned to one of six grades and mapped accordingly, A comparison of this map with Smailes' map of the urban hierarchy reveals more differences than similarities. The larger cities, e.g. Nottingham, Derby, Leicester have a fairly low per capita sales grading whereas several small market towns are very high. It is true that the larger centres may have high per capita sales in certain specialised retail sectors, but their overall per capita retail sales do not match their importance as regional centres.

Siddall [15] uses a slightly different approach in examining large American urban areas. He suggests that wholesale/retail trade ratios are good indices of urban centrality. Throughout the county wholesaling is shown to account for 18.8% of the total workers in wholesaling and retailing combined. A figure higher than 18.8% for an individual city indicates that it is overdeveloped as a wholesale centre and it must be serving a disproportionately large retail hinterland.

This is a method which can only be accurately applied to large urban agglomerations and Siddall limits his study to fifty-six standard metropolitan areas exceeding 300,000 inhabitants. Among these cities the ratio is found to range from a maximum of 25.9% in Omaha to a minimum of 12.3% in Washington. Centrality measured in this way is largely independant of population.

Tarrant [16] points out that the existence of a function in a settlement is not an indication of a central function performed by that settlement. In order to get round this difficulty in a

Central Place study of part of Yorkshire he considers three apsects of each town's retail structure, viz. (1) total number of shops, (2) number of types of shops, (3) number of specialist shops (which are defined according to circumstances). Having collected these three types of data, a hierarchy is constructed using a method of grouping outlined by Berry [17] which permits groups to be formed at varying degrees of generalisation, and with measurable losses of accuracy. The number of different types of shops in a centre emerges as the best measure of a towns status.

An examination of retail centres for the whole of Britain was undertaken by Thorpe [18] using data from the 1961 Census of Distribution. A subjective hierarchy was suggested, based upon seven groups of retail turnover from Regional Centres doing over 35 million pounds of business every year down to village or small suburban locations with less than one million pounds. The "average centre" is shown to be very rare, so within the hierarchical groups there is considerable diversity.

In Sweden Sven Godlund [19] approaches the problem of centrality from a different angle. His study is interesting in that it is one of the very few based upon an occupational index. Godlund attempts to measure the capacity for service and trade in each centre; for this purpose he derives an index of centralisation as follows :-

$$\text{index of centralisation} = \frac{\text{No. of persons actively engaged in retail \& service} \times 100}{\text{Total population of the urban settlement}}$$

The higher the index the greater is the importance of the town as a centre for a hinterland. The average index for all of Sweden is 3.9 and the following settlement ranks are identified :

1.	Regional Centre	Index	> 6.5
2.	Townlet Centre		5.5- 6.4
3.	Township Centre		4.5- 5.4
4.	Market Centre		3.5- 4.4
5.	Special Urban Centre		< 3.5

Godlund's main contribution to central place studies is through his work on bus services and hinterlands but this will be reviewed in a later section.

More recently in this country the main contributions in this sphere have come from planning circles; the study of retail trade in the Midlands by **Lomas** [20] is a good example. In this study, centres are defined by bus hinterlands from the Local Acessibility Map and the aims are threefold :

(1) to estimate the total population supporting each centre

(2) to evaluate and classify central area facilities

(3) to compare towns as service centres, one with another.

Five key retail groups are chosen, and these, together with two non-retail functions, are graded by points from 1 to 8 according to different degrees of provision of the function. Thus the maximum number of points attainable is a maximum of 8 in seven sectors — a total of 56 which is attained solely by Birmingham.

The research group of the West Midlands Branch of the Town Planning Institute [21] have made use of a new range of techniques in aWest Midlands shopping survey. Some correlation is found between the indices used in the Haydock shopping survey [22] and the total central area turnover in durable goods in many centres. The correlation is especially good in larger centres but the

smaller ones possess so few of the key indices that the presence or absence of just one could sway the result by as much as 25%. Clearly, if smaller centres are to be included in the investigation, more commonly occurring indices will have to be chosen.

Catchment areas were defined for the shopping centres using a combination of the Haydock technique and Reilly's Law. The attraction of centres was assessed by comparing the known retail turnover for each town with expenditure generated within their hinterlands. The latter was calculated from Ministry of Labour Regional Expenditure figures. Only towns large enough to be included in the Census of Distribution were considered and the resulting pattern for parts of Staffordshire, Cheshire and Shropshire is shown in figure 2.1

A sophisicated approach to the study of shopping centres has been undertaken in south London by Rhodes and Whitaker [23] using a modified form of gravity model. This is essentially a consideration of consumer spatial behaviour but it is included in this section because it concerns only one aspect of a centre's attributes — that is its retail status. Similar investigations have been made elsewhere and the gravity model may prove a useful tool in future central place study but it requires more empirical application to put it on a firm foundation.

This section is not an exhaustive study of all the documented work which has been done in this area. Space has permitted only brief discussion of the principles behind the research contributions quoted. Many of the studies cannot be considered as pure Central Place analyses but they offer interesting techniques and often valuable results,so they have been included

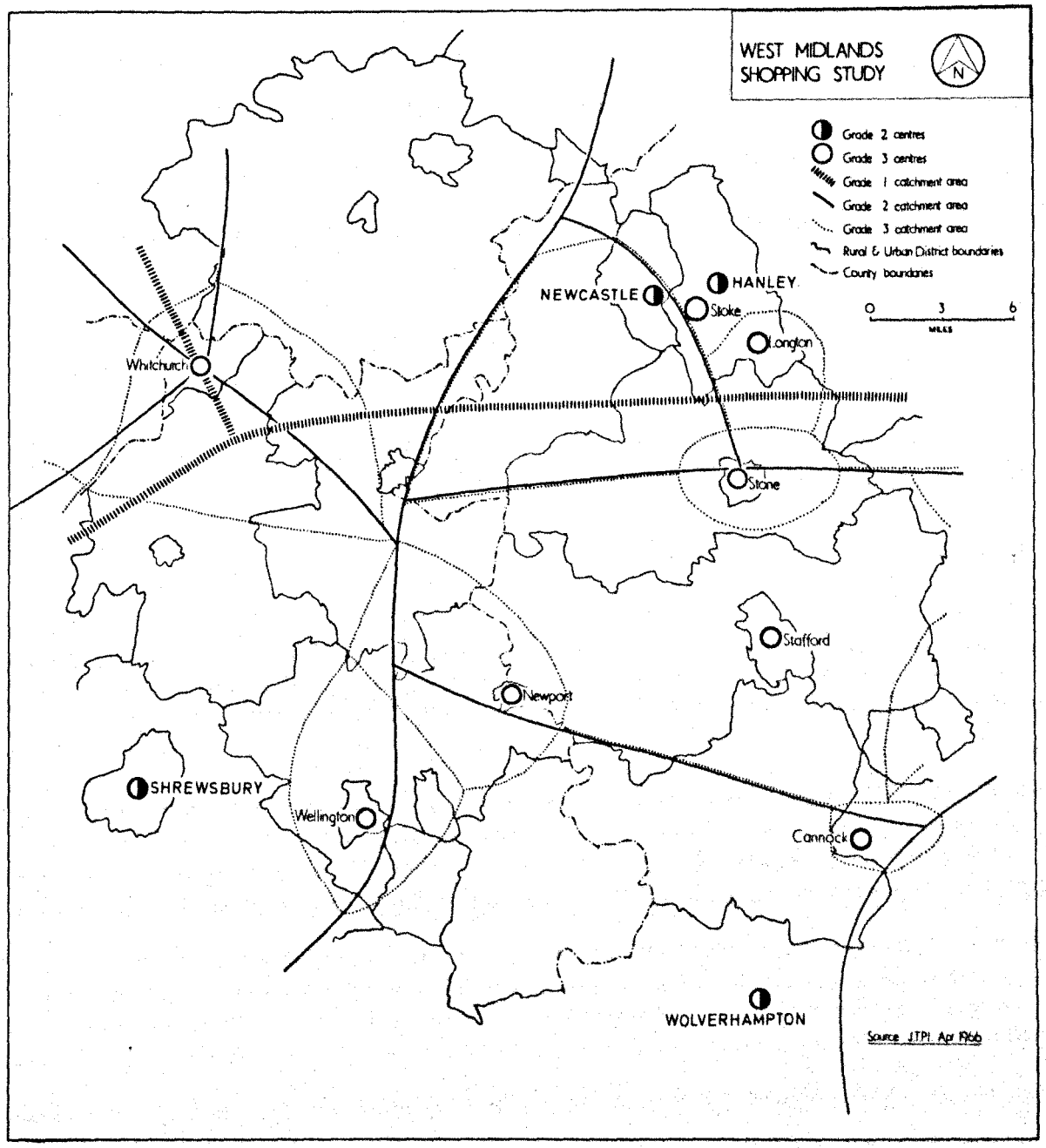

Fig. 2.1 Catchment areas of shopping centres in the N.W. Midlands.

in this review. In some cases nc attempt has beem made to construct a hierarchy of centres but even where these attempts have been made they are frequently unconvincing. In particular many of the studies lack an acceptable identification of the common characteristics within each grade. Despite their shortcomings these techniques should not be dismissed, for their advantage over theoretical or more geographical methods is that they possess widespread practical applications. They are valuable tools for the urban developer and the town planner.

II 2 Hinterland Studies

(a) Hinterlands determined by accessibility to the Central Place

In this section it is proposed to examine those methods of Central Place study which concentrate upon the linkages connecting a centre with its hinterland or zone of influence, and attempts at measuring the accessibility of the centre. The concepts of centrality and accessibility are closely allied: the greater the accessibility the more pronounced is the centrality of the place and the greater and more specialised its economic development.

Many investigations of town hinterlands have been undertaken in the last few decades but only a small number are germane to our discussion. Frequently there is no attempt to rank the centres into a hierarchy and sometimes only one level of the scale is considered. Nevertheless these studies are valuable in that they help to identify the regional importance of central places.

One of the earliest studies of this kind in Britain was that undertaken by F.H.W. Green in the southwest of England.[24] In his subsequent major study[25] Green considers the whole of England and Wales. Somewhat blandly and without explanation he introduces the

concept of a five-fold hierarchy of centres and suggests that fourth order centres and their hinterlands can be particularly well defined using data provided by bus timetables. A centre was at least fourth order if bus routes radiated from it and served no place larger than the centre itself. Hinterland boundaries were drawn where services to one centre gave way to those from a competing centre. Hinterlands thus defined were found to overlap slightly and Green discussed the use of questionnaires and other means of fixing the boundaries.

Comparing the 700 fourth order centres defined by this method with the 708 found by Smailes using different criteria, there was found to be considerable similarity. In 1952[26] Green attempted to show that his bus service index was a suitably flexible technqiue for investigating a changing situation. He compared a hinterland map of 1947 with one for 1949/50 and found that no place had fallen in status, but that in the south of England seventeen new centres had qualified. Some attempt was made to grade centres into a hierarchy. For each centre the number of buses per day was plotted against the percentage serving no place larger, and lines were drawn to separate second and third order centres from others, but Green's reasoning is tenuous and his results are to some extent presupposed.

In this and a subsequent article,[27] Green subscribes to the view of Losch that for each product or service there is a lattice of hexagonal trade areas covering the area in question. However the lattices are arranged, there will be points where the centres of two or more hexagons coincide; at the point where they all

come together will be found the metropolis for that area. Lesser coincidences represent smaller trade centres. For Britain Green identifies the following main orders of centres :-
(1) First order or metropolis, (2) Second order or provincial capitals such as Glasgow, Manchester. (3) Third order, subdivided into 3A, 3B and 3C. (4) Fourth order or district centres.
(5) Fifth order or service villages.

This work by Green points to his belief in separate orders in the hierarchy of settlements, but it falls short in explaining how these ranks can be objectively identified, and the features by which they are characterised.

A similar study was undertaken by Carruthers [28] who concentrated on fourth order and above centres. Town/country associations, and thence a measure of a town's status were deduced from an analysis of bus services. A graph of the total number of Saturday buses into a centre against the percentage serving exclusively smaller places revealed a continuous range from small towns to major regional cities with no obvious breaks. This study owes something to the works of both Smailes and Green but again no objective basis can be discerned for the selection of hierarchical groups.

The contributions of Scandinavian geographers to the study of central places has been considerable, and among these works is the comprehensive analysis of public transport services undertaken in Sweden by Godlund.[29] It has already been seen in an earlier section how Godlund derived an index of centrality, but he further points to the need to consider those services and functions which cater for the needs of a town separate from those which serve the

centralised region. Much of this study is concerned with the growth of central places and urbanisation, and it is shown towns with the highest centrality index also had the earliest 'bus services. In many cases, long-established central places tended to stagnate if they were by-passed by the railway. One of the main tenets of Godlund's discussion is that the influence of a centre varies in intensity throughout its 'field' and that the field of the town has no boundaries but decreases in strength to zero at an infinite distance from the centre. The term umland is prefered to describe that part of the field in which the one central place is dominant over all others.

It is shown that in southern Sweden most of the smallest settlements are located on the boundary of the 'bus hinterlands of the larger towns. A series of graphs — Figure 2.2 — illustrates conditions favourable to the growth of a central place. A and B are central places of similar size and the vertical lines between them represent smaller settlements. The curves show the degree of influence between the central places and small settlements. All of the latter have very low centrality and equal opportunities for growth. In ii the new central place is developing at C, where the influence of A and B is weakest. In iii it has grown further and possesses its own small area of influence and in iv it has attained the same degree of centrality as the two original centres and the process is beginning again between A and C and C and B.

In an extended programme of research into the social geography of a part of north west Yorkshire Johnston [30] has derived an index of accessibility from a study of transport patterns. In an area containing nine towns and 223 villages he has examined the 'bus services according to the following four divisions :-

(1) journey to work (2) travel to shopping
(3) travel to entertainment (4) length of journey

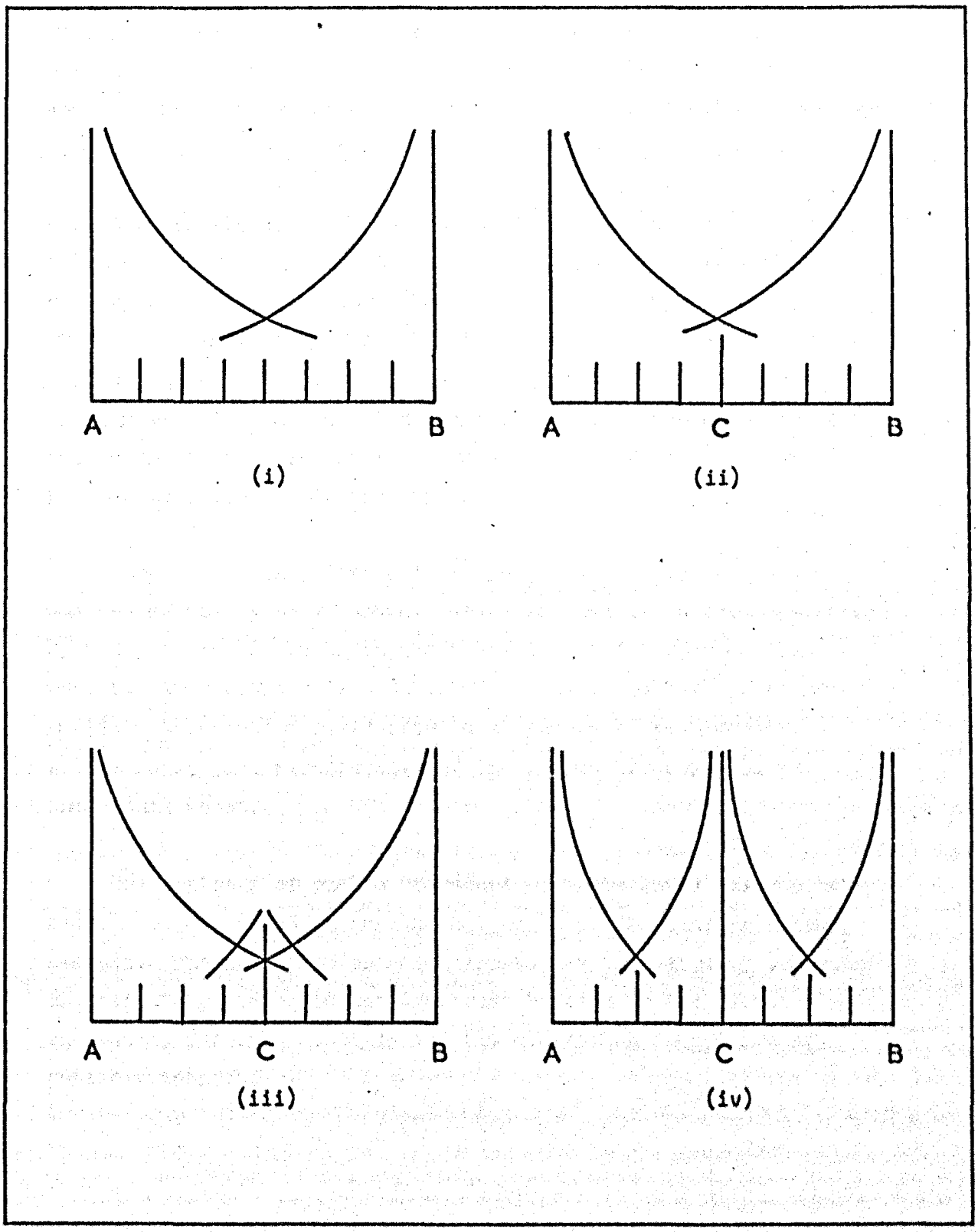

Fig. 2.2

Each village is considered in turn and points are awarded to it for every accessible centre. The system is based on the village's weekly 'bus services. For the journey to work, a bus arriving in the relevant centre before 8a.m. scores two points and one arriving before 9a.m. scores one point. A point is awarded for each service which arrives in the town between 9.00a.m. and 3.00p.m. allowing at least an hour for shopping before the return service. Points are also scored for 'buses which return to the village late at night and in all cases a journey of less than half an hour rates a higher score than one of longer duration. The village is finally placed in the hinterland of the town which claims the largest number of the village's total point score. The hinterland of a town is defined as the area dominated by its provision of services, and the boundary occurs where one town becomes more accessible than another.

Very little correlation is found (0.54) between village size and accessibility to a centre. Accessibility is in fact dominated by the pattern of the urban areas and by the inter-urban 'bus routes. No hierarchy is postulated but it seems that if slightly modified this method could provide a measure of town/country relationships, and particularly of the degree of dominance of individual towns.

The analysis of public transport patterns would seem to have their greatest value in the investigation of the smaller urban centres. The more sophisticated approaches indicated by Johnston are certainly desirable but they must be seen in the light of increasing personal mobility and the decreasing importance of public transport.

(b) Studies of comsumer movement patterns

The final aspect of central place study to claim our attention is an examination of those methods which seek to determine which towns are most frequented by rural dwellers. Essentially these are investigations into country/town relationships and assessments of the degree of attraction of competing centres. An increasing awareness of the limitations of central place studies which examine only the functions possessed by settlements had led to many investigations of the links between centres and their surrounding populations.

One of the earliest works of this kind was that conducted by Bracey between 1952 and 1960. In seeking a satisfactory method for examining the towns of Somerset, Bracey [31] dismissed a direct count of shops and services as being inaccurate and unsuitable for towns larger than 2,000 people.(i) His alternative was to prepare a questionnaire to reveal which towns were used by the rural dwellers for their shopping and professional needs. This form was circulated to responsible people in each parish but in no sense was a genuine sampling attempted. The respondents were asked where they obtained the following :-

Clothing: gents, ladies boots and shoes: household goods: hardware, electrical, radio, furniture. Medical services: doctor, dentist, optician, chemist. Other professional services; bank, solicitor, accountant, auctioneer.

(i) a separate study examined the service provision of smaller centres. These are classed as 1st order villages having 20 or more shops, 2nd order — 10-19 shops and 3rd order — 5-9 shops. The total number of different services available is more diagnostic than the number of establishments. Bracey H.E. English Central Villages: identification, distribution and functions. I.G.U. Symposium, Lund 1960 p. 169.

Each service was awarded one point and for every village the 15 points were allocated to the centre or centres at which the relevant services were normally obtained. In the event of people from one parish regularly visiting more than one centre the point was split between those centres. No account was taken of the differences in parish populations and inadequate allowance was made for the parishes with more than one distinct village nucleus. For each town the addition of the scores of all villages allied to it resulted in an index of centrality. In Somerset this was found to range from a maximum of 815 for Taunton to less than 30 for small service centres, and it was observed that six towns formed a group with indices greatly superior to all other centres. The index illustrated that size is not always an accurate indication of a town's importance as a service centre, and Weston-super-mare, the county's second largest town was ranked eighth.

Plotting the villages' scores on a map revealed that around each town there are three fairly distinct zones with the degree of affiliation to the centre decreasing outwards. The inner, or intensive zone embraced villages awarding more than half their maximum number of points to the town in question; this was followed by a belt designated the extensive zone with villages scoring less than half the possible number, and finally an outer, or fringe zone with very low scores.

Bracey suggested that with so few centres a hierarchy would be difficult to demonstrate. However the following grouping was tentatively put forward.

First grade — containing eight towns with certain features in common. All have service areas with populations exceeding 18,000, and large intensive zones. These towns were called District Centres. A second grade with lower indices of centrality

and small intensive areas were named Local Centres. Further division would be questionable, but it is possible to recognise an additional group of small towns and villages with distinct central place functions.

In conclusion Bracey suggested that a system which considered only shopping, banking, medical supplies and entertainments could reliably replace the unwieldly 15 point questionnaire, and in a later study [32] this is tested. The field area is also extended to cover six contiguous English communities — Somerset, Wiltshire, Dorset, Hampshire, Berkshire and Oxfordshire. Towns in this area are divided into two groups, largely on the basis of the relative size of their professional and shopping indices. The first group is the Higher District Centres with a shopping index greater than the professional one, and the second group, or Lower District Centres have their indices reversed. The method illustrates the relatively minor centrality of coastal and specialised towns such as Portsmouth and Aldershot. The paper was written in 1956 and Bracey recognised the fluidity of the situation. Post-war town centre renewal may have altered the pattern considerably, and the position of Southampton for instance was no doubt underestimated.

Spatially, a fairly open, evenly spaced network was identified with the mean separation of higher district centres being 21 miles. Except in the case of the New Forest the whole area was well served, and there was found to be a frequent slight overlapping of hinterlands.

An interesting comparison of this method, and assessment of central place functions has been carried out by Bracey and Brush [33] in southern England and south west Wisconsin. In the latter area centrality was determined by assessing the businesses and functions

found at the centre, and in England Bracey's index of rural centrality was used. In both cases service areas were mapped. A higher order of centres could be recognised in the two areas but no sharp break separated them from lower order settlements. Many coincidences were found in the two countries, especially with regard to the spatial distribution of centres. In England the higher order towns show well developed shopping functions, but a surprisingly large range of professional services can still be found in the smaller centres, although this is not true of Wisconsin.

Following directly from the lead of Bracey is a study by Whitelaw [34] in New Zealand. This is an examination of the competition and varying degrees of attraction between towns, and shows that such areas are not homogeneous, and are neither exclusive nor necessarily continuous. As Bracey found in Somerset, so Whitelaw identifies in the Waikato that there are zones of decreasing itensity of attraction extending outwards from the centres. The method developed by these two workers is most useful in analysing town/country relationships, and is especially suitable for distinguishing between urban and rural components of centrality. It offers a method of grading centres without indicating class boundaries or characteristics with any clarity.

One of the directions in which contemporary central place study is moving is towards an examination of consumer behaviour in the context of hinterland — centre relationships, and an example of this is the study by Thorpe and Nader [35] in Durham. A questionnaire approach was used to investigate consumer orientation, and it was found that there was considerable evidence

for four ranks of shopping centres. It is also shown that the trading areas for shopping centres overlap and compete with one another and that there is never a state of equilibrium. The concept of threshold is extended and it is suggested that for any given type of good, the threshold is increased higher up the hierarchy because the type of outlet changes. The work of Thorpe and Nader is a valuable contribution to the understanding of central place systems, but it should be noted they use "central place" and "shopping centre" as synonymous terms.

In south Hampshire Davies and Robinson [36] have examined the mobility and orientation of consumers in order to identify a nodal structure for the region. Again, a questionnaire approach was used and the method has been concentrated on shopping journeys, which, for the individual vary considerably as to their frequency, distance and exact purpose. The area was divided into small units and from each of these sub-areas the flows of people to other places were ranked according to the size of movement. At the first order of flow, nine dominant nodes were identified plus eighteen subsidiary and three isolated centres. No indication of the size, or relative importance of the centres is given but this method does produce a fairly accurate picture of the linkages between towns and their tributary areas. The work has been criticised by Thorpe [37] who suggests that the situation has been oversimplified, especially with regard to the lack of consideration of frequency of trips and to the lack of distinction between different types of journey.

For the most part this chapter has concentrated on a critical examination of the methodology and techniques which have been used for central place study. It has not been possible to do justice to the contributions of all workers, but examples have been given of most of the main categories of research, and the reader is referred to the bibliography complied by Berry and

Pred [38] for more detailed references. Papers which are directly relevant to central place study, and which have appeared since 1964 are selectively listed in the following bibliography.

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Chapter 3 - Centrality, and the functional complexity of settlements.

Within the area studied the functional complexity of settlements as service centres ranges widely; from the small village or hamlet with only one or two identifiable functions to the large urban service centres with many hundreds of discrete functions. A large volume of data relating to the distribution and incidence of these functions has been gathered, and it was decided that the method of presentation which would allow most meaningful analysis and which would permit the most straightforward comparison of the aggregate centrality of the different settlements was that of a large matrix. Accordingly a matrix, Appendix A, was prepared, in which settlements were listed in rows, and the functions they possessed in columns

It would be virtually impossible to measure (and subsequently impracticable to process) all of the diverse retail, service and social functions performed by a large town or city. Therefore in compiling a selective list, some subjective judgements must be made. It cannot be denied that some degree of order obtains among the aggregate of these functions, from the most lowly and commonly occuring, to the highest order functions found only rarely and then only in major centres. J.D. Carrol[1] approaches a definition of this functional complexity by stating "The smallest cities will perform a small pyramid of functions. At the base of the pyramid will be the most ubiquitous functions – perhaps friendship and visiting. Next may be grocery and drug stores, and at the top will be that single function which is most specialised of all that city's functions — for example a departmental store." In choosing a range of index functions with which to measure the status and centrality of settlements ranging in size from hamlets of less than 100 people to towns of nearly 100,000 one must be aware of the different importance of functions at different levels of the pyramid. For instance, it

would be possible, although in this case shortsighted, to chose a range of functions which were unduly weighted in favour of one particular size of settlement. The extreme might be to consider solely butchers' shops, in which case the town with a dozen such establishments would be shown to be twelve times as important as the village with only one, and a settlement without any would be perhaps falsely, shown to have nil centrality. No list of functions can hope to be exhaustive and still remain manageable; the only practicable approach is reasoned selection but some risks of bias are bound to be introduced. In selecting functions for incorporating in the matrix many major high order functions have been included, but a number of humbler functions towards the base of Carrol's pyramid have also been selected, since these are particularly significant in isolating rank differences low in the hierarchy.

Sixty functions were deemed to be relevant and measurable in the present study, although for some purposes a partial list was used. Wherever possible 1969 was taken as the base year, but in the few cases where this was not possible the discrepancies were not considered vital. Details of the sources of the data used are shown in appendix A.

Traditionally the retail functions of a town have been given great prominence as a index of centrality, so there is substantial precedent for their continued use. The value of retail measures of urban rank is well documented but two aspects are worthy of emphasis. Shops, of one kind or another, are probably the most extensively and frequently used of all a town's functions, and the task of measurement and comparison is feasible, although complicated by varying size of units, turn-over, labour employed and the quality

of goods offered. In addition a certain amount of statistical material is available from the 1951 and 1961 Censuses of Distribution, although again it requires careful treatment. Against the advantages must be set the fact that a town's retail provision paints an incomplete picture of overall urban status. It will be shown later that in most cases the retail status of a town is closely correlated with its standing as measured by other criteria, but for the moment retail functions must be considered only as a part of a settlement's centrality.

The dangers associated with measures of rank based only on retail functions do not operate uniformly throughout the scale of settlements; in particular such measures tend to minimise the importance of small towns and villages which often have a service and social centrality greater than their retail importance.

The Functions

A substantial proportion of the functions included in the matrix are therefore of a non-retail nature. Broadly the functions fall into five groups; (1) retail (2) professional and financial services (3) personal service (4) county services (5) social facilities and activities. These groups are in no way exhaustive, neither are they definitive; rather they have been chosen as groups of functions representative of five aspects of centrality. Throughout this study it has been attempted to extend the scale of investigation to include settlements which are very minor centres, but the degree of functional provision at the lower level is often such that these minor centres have been excluded from the fullest analysis of the matrix.

Within the retail group no absolute distinctions were made as to the size of units, but a fairly fine subdivision into functional types of establishment provided a realistic classification. For instance "food shops" were subdivided into (a) general stores,

(b) grocers (c) supermarkets (d) grocers/greengrocers (e) greengrocers/fruit/flowers (f) butcher (g) dairyman (h) poultry/game/wet fish (i) bread/flour confectioners (j) health foods/delicatessan. For some purposes it was found useful to reduce the retail groups into a number of coarse divisions — e.g. food, clothing, hardware, etc.

In order to standardise the survey data, the central area of each settlement within which shops were listed was defined as in the Board of Trade Census of Distribution. The boundary was thus taken as the point along the shopping streets at which more than one building in three was occupied by non-retail functions. The problem of delimiting the central area became more severe for the larger towns, and the most complete solution would have been a detailed C.B.D. analysis. This however was not practicable, and the 'rule of thumb' standard worked satisfactorily.

In the larger towns the focus of the central area was found to be occupied by large units, usually extensively modernised, or newly built, and the typical functions included departmental stores, clothing shops (especially ladies outwear), multiple stores, and banks. Progressing outward from the centre shop units generally became smaller and sales areas were confined to the ground floor. The appearance of shops at the margin is generally dowdy, and functions typically present were second-hand/junk shops, small clothing stores, pet shops, "do-it-yourself and builders merchants, small general stores and other neighbourhood types. The fluidity of the central area boundary was frequently shown by vacant shops and derelict sites.

In the smaller towns, which have attracted little retail investment, most of the shop units were found to be modest in size and apparently not modern in appearance or organisation. Nonetheless

towns of this kind, such as Market Drayton, Whitchurch and Wellington show strongly nucleated and well defined central areas.

The professional and financial group of functions was chosen for its relevance to rank-order among the smaller settlements as well as for the larger towns, but in practise it naturally gave pre-eminence to the latter. Nine representative functions were considered— post office, bank, doctor, dentist, optician, solicitor, accountant, auctioneer and vetinary surgeon. As with the retail group, banks and post offices were tabulated according to the number of establishments; the others were list according to the number of qualified members of the relevant professional body associated with each. Personal services was a small group composed of ladies hairdressers, dry cleaners, turf accountants and travel agents. For many analytical purposes this group was included with the one above under the general heading of "services". County services constituted a group including several functions with a very widespread occurrence, so it was one which made possible the inclusion in the matrix of many small villages. The members of this group were (a) primary school (b) secondary school, (c) district nurse (d) library, or visits by a mobile van (e) police. It could be argued that some of these are not true measures of centrality for the service itself is mobile, but the possession of the function does give a village some centrality, and the location of the services must be decided with due regard for an efficiently spaced coverage.

The fifth group, that of social functions, was a relatively unusual one. The range of social facilities and activities present in a settlement has not previously been considered as an aspect of centrality, but at the village level this can be an important element

in the overall pattern. At higher levels social functions provide a more dubious index of centrality for they tend to be suburban in location and organisation,and in substantial towns it is almost impossible to survey them completely.

The data from which the social provision has been assessed has limitations. Much of it is perfectly consistent, for instance the presence or absence of village halls and churches was obtained from rating lists and addresses supplied by the Councils of Social Service. Information on social organisations within the villages was obtained from a questionnaire sent to the Clerks of the parish councils or village hall committees, and like all questionnaires it met with an element of non-response. The useable response rate was at the very high level of 87.5 percent, but where replies were not forthcoming, this was taken as an indication of a lack of social activity or organisation in the village concerned. The details of the social investigation and the interpretation of the results appear in Chapter 5.

The settlements

In the original collection of data a settlement was included if it possessed even one of the functions being considered. This process gave rise to a list of some 274 separate locations and included many small hamlets with specious claims to centrality, so a constraint of minimum functional requirement was introduced. Due to the varied , and by no means uniform functions which occurred in lower order villages it was decided to include only those settlements which possessed at least two functions from the short list of (1) post office (2) shop (3) primary school (4) village hall. The resultant list then included 191 settlements. No

population constraints were imposed, but the settlements listed ranged from Newcastle with a population of nearly 80,000 to numerous small and functionally simple villages of less than 100 people and typically boasting no more than two or three functions from the list.

The raw material of the matrix was transformed into a more maneagable form by the use of location coefficients as demonstrated by W.K. Davies.[2] Briefly this method is based upon the calculation of a location coefficient for a single outlet of any functional type. The greater the rarity of a function, the higher will be its centrality score. The location coefficient (C) is given by

$$C = \frac{t}{T} \times 100$$

where t = one outlet of function t
T = total number of outlets of function t.

Each functional type then gives a centrality value to each settlement which possesses that function, calculated as C x the number of outlets of that function in the settlement.(1) An overall functional score can then be derived for each settlement by the addition of all of its centrality values, and in this manner the list of 191 settlements was ranked according to their functional complexity.

It should be noted that the main weakness of this method is that it is based solely upon the frequency, or rarity of occurrence of establishments of different functional types, and not upon use characteristics. Thus an establishment dealing in office equipment will have a very high centrality value based upon its rarity of occurrence, although the large majority of people will seldom, if

(1) A refinement of this method allows for each outlet to be weighted according to its turnover or number of employees. Details of retail turnover however were not available, and the size of the study area made personal interviews with every shop manager impossible.

ever, require such an establishment. Conversely the frequently used, and frequently occurring grocers store will have a low value. Measured in terms of journeys generated, then, the functions would be arranged almost in the inverse order of their centrality values.

In the present situation the advantages of the method were seen to outweigh its disadvantages. Chief among the advantages was the fact that it was possible to compare unlike variables in an objective fashion — for instance it was possible to compare retail establishments with service functions. Additionally it allowed the total functional complexity of each settlement to be expressed by a single number.

Results

One of the main purposes of the matrix of settlements and functions was to enable comparisons to be made between the rankings of settlements according to different criteria. These criteria were the broad groups into which the functions were divided, but population rank was included for purposes of comparison. It proved possible to perform complete rank correlation tests for only the 34 largest settlements. (1) The reasons for this were twofold: smaller settlements could only be ranked according to the three broad groups of retail, service and social functions; for there was insufficient detail to permit these groups to be subdivided, and in any case the social group had no counterpart among the larger centres. Secondly, below a certain level of functional complexity

(1) here defined as those with the highest combined score on retail and service functions.

many villages recorded identical scores giving tied ranks which reduced the reliability of statistical rank correlation methods. A complete list of settlements with their scores and ranks is given in Table 3.1.

The short list of 34 settlements was ranked by these centrality values under the following headings:

1. Food
2. Clothing
3. Hardware
4. Other retail
5. Non-food retail
6. Total retail
7. Professional and finacial services
8. Personal services
9. County services
10. All services
11. Total retail and services
12. Population.

The basic object of the rank correlation exercise was to measure the degree of correlation between the twelve independent rankings of the 34 settlements. Obviously some of the rankings are more important than others for comparative purposes, and equally obviously not all of the dozen rankings are completely exclusive. For instance, a high degree of correlation between No. 1 food, and No. 6 total retail would be expected a priori since the former is a major component of the latter.

When the settlements are arranged together it can be seen superficially that there is substantial agreement between their rank orders. This is confirmed for those columns which are exclusive i.e. food, clothing, hardware, other retail, professional/ financial services, private services and county services, by a Kendall's coefficient of concordance of W= 0.847 which is significant at the one percent level.

A more refined view of the intercorrelations is obtained from Spearman Rank Correlation coefficients (ρ) calculated for each of the twelve methods. This results in table 3.2, a

TABLE 3.1

CENTRALITY VALUES AND THE RANKING OF SETTLEMENTS

Settlement	Retail Score	Service Score	Retail+ Service Score	Retail Rank	Service Rank	Retail+ Service Rank	Social Score	Social+ Retail+ Service Score	Social Rank	Final Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Shrewsbury	705.35	259.67	965.02	1	1	1				
Newcastle	506.57	234.07	740.64	3	2	2				
Stafford	543.32	173.95	717.37	2	4	3				
Crewe	368.46	183.70	552.16	4	3	4				
Nantwich	322.15	107.91	430.06	5	6	5				
Wellington	258.54	123.84	382.38	6	5	6				
Whitchurch	235.83	61.86	297.69	7	10	7				
Market Drayton	181.27	78.70	259.97	8	8	8				
Oakengates	138.62	79.08	217.71	9	7	9				
Stone	135.08	61.52	196.60	10	11	10				
Newport	107.41	71.30	178.71	11	9	11				
Shifnal	66.40	30.65	97.05	13	12	12				
Wem	66.50	30.38	96.88	12	13	13				
Donnington	60.13	18.17	78.30	14	16	14	2.29	40.61	68	
Hadley	51.96	11.02	62.98	15	21	15	1.77	64.76	70	3
Penkridge	44.67	17.36	62.03	16	17	16	18.93	80.96	1	1
Eccleshall	36.03	21.42	57.45	17	15	17	9.83	67.28	15	2
Audley	27.90	26.18	54.08	18	14	18	8.43	62.51	23	4
Gnosall	18.60	14.71	33.31	21	18	19	15.06	48.37	2	5
Shavington	23.44	7.99	31.43	20	25=	20	11.79	43.22	6	6
Bignall End	23.76	5.67	29.43	19	34	21	.52	29.95	130=	10
Audlem	15.93	13.22	29.15	22	19	22	9.10	38.25	20	8
Shawbury	13.61	11.70	25.31	24	20	23	11.16	36.47	9	9
Willaston	14.74	4.92	19.66	23	35	24	.26	19.92	138=	12
Woore	10.53	8.14	18.67	26	24	25	10.37	29.04	13	13
Madeley	10.46	8.16	18.62	27	23	26	10.99	29.61	10	11
Haslington	10.79	6.50	17.29	25	30	27	12.20	29.49	5	12
Great Haywood	7.05	9.03	16.08	31	22	28	6.80	22.80	27	15
Barlaston	8.53	5.89	14.42	29	33	29	6.92	21.34	26	18
Hodnet	8.05	6.16	14.21	30	31	30	11.58	25.79	7	14
Wheaton Aston	10.25	3.16	13.41	28	51	31	6.47	19.88	28	20
Betley	5.85	7.02	12.87	32	27	32	9.94	22.82	14	16
Bunbury	3.64	7.99	11.63	34	25=	33	11.17	22.80	8	17
Prees	5.39	5.99	11.38	33	32	34	1.51	12.89	73=	27
Wistaston	1.21	6.79	8.00	44=	28	35	10.52	18.53	11	22
Hixon	1.28	5.48	6.76	43	29	36	5.29	12.05	39	29
Halmer End	3.43	3.23	6.66	35	49	37	1.26	7.92	75=	42
Wrenbury	1.29	4.21	5.50	41=	38	38	1.00	6.50	83=	53
Ashley	0.48	4.40	4.88	58=	37	39	13.82	18.70	4	21
Loggerheads	0.24	4.56	4.80	95=	36	40		4.80	168=	71
Edgmond	1.29	3.50	4.79	41=	48	41	9.31	14.12	18	25
Weston under Lizard	.48	4.05	4.53	58=	39	42	3.01	7.54	65	45
Hinstock	.90	3.53	4.43	50	44=	43	9.81	14.24	16	24
Weston (Crewe)	.48	3.94	4.42	58=	40	44	1.51	5.93	73=	60
Haughton (Staff)	.77	2.58	4.35	38	63	45		4.35	168=	77
Weston (under Trent)	.48	3.53	4.01	58=	44=	46	7.42	11.43	24	30
Woodseaves	.48	3.51	3.99	58=	46=	47=	4.06	8.05	49=	41
Tittensor	.48	3.51	3.99	58=	46=	47=	.26	4.26	138=	80
Swynnerton	.24	3.59	3.78	95=	41=	49=	1.26	5.04	75=	69
Wrockwardine	.24	3.54	3.78	95=	43	49=	1.00	4.78	83=	72=
Blythe Bridge	.73	3.03	3.76	51=	53	51	.26	4.02	138=	84
Alsagers Bank	2.66	0.99	3.65	36	141	52	.52	4.17	130=	81
Worleston		3.59	3.59	160=	41=	53	.74	4.27	124=	79
Milford	1.21	2.24	3.45	44=	73=	54	1.71	5.16	71=	64=
High Ercall	.24	3.17	3.41	95=	50	55	10.42	13.82	12	26
Cheswardine	2.00	1.39	3.39	37	105=	56	9.01	12.40	21	28

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Bromstead Heath	.73	2.64	3.37	51=	59=	57	1.00	4.37	83=	75=
Sandon	.48	2.85	3.33	58=	55	58	1.00	4.33	83=	78
Walton	.48	2.84	3.32	58=	56	59	.74	4.06	124=	83
Alpraham	.97	2.24	3.21	46=	73=	60	.52	3.73	130=	87
Church Eaton	.24	2.94	3.18	95=	54	61	4.03	7.21	50	47
Wood Lane	1.76	1.39	3.15	39	105=	62	.77	3.93	123	85
Oulton	.48	2.65	3.13	58=	57=	63=	5.26	8.93	40	36
Hilderstone	.48	2.65	3.13	58=	57=	63=	3.46	6.59	61	52
Whitmore		3.11	3.11	160=	52	65	13.92	17.03	3	23
Brocton	.73	2.42	2.97	51=	65	66	6.15	9.12	31=	34
Clive	.48	2.45	2.93	58=	64	67	6.04	8.97	33	35
Cotes Heath	.24	1.39	2.88	95=	105=	68=	4.28	5.67	44=	61
Croxton	.24	2.64	2.88	95=	59=	68=	1.26	4.14	75=	82
Great Bridgeford	.48	2.25	2.73	58=	71=	70=	5.36	8.09	38	40
Prees Higher Heath	.48	2.25	2.73	58=	71=	70=		2.73	168=	110=
Dunston		2.64	2.64	160=	59=	72=	1.00	3.64	83=	88=
Dailey		2.64	2.64	160=	59=	72=	1.00	3.64	83=	88=
Albrighton	.24	2.36	2.60	95=	66	74	.26	2.85	138=	105
Hales	.24	2.28	2.52	95=	68	75	3.42	5.95	62=	59
Seighford	.24	2.26	2.50	95=	69=	76=	3.68	8.18	55	39
Mucklestone	.24	2.26	2.50	95=	69=	76=	.26	2.76	138=	106=
Standon	.24	2.24	2.48	95=	73=	78=	3.88	6.36	51	54
Bulkley	.24	2.24	2.48	95=	73=	78=	1.00	3.48	83=	91
Hopton	.24	2.24	2.48	95=	73=	78=	.26	2.74	138=	108=
Baldwins Gate	.97	1.51	2.48	46=	93	78=	.26	2.74	138=	108=
Waters Upton	.24	2.19	2.43	95=	79=	82=	1.00	3.43	83=	93=
Spurstowe	.24	2.19	2.43	95=	79=	82=	1.00	3.43	83=	93=
Loppington	.48	1.99	2.47	58=	82	84=	.52	2.99	130=	101
Wetwood	.48	1.89	2.37	58=	84	85	.74	3.10	124=	99
Wybunbury	.97	1.39	2.36	46=	105=	86	1.26	3.62	75=	90
Cholmondeley		2.33	2.33	160=	67	87	.26	2.59	138=	115
Stowe by Chartley	.48	1.84	2.32	58=	87	88	3.81	6.13	54	55
Tong Norton		2.24	2.24	160=	73=	89	.26	2.50	138=	116
Miles Green	1.70	.53	2.23	40	179=	90		2.23	168=	126=
Tern Hill		2.19	2.19	160=	79=	91	.26	2.44	138=	122
Marbury cum Quoisley	.24	1.92	2.16	95=	83	92	1.00	3.16	83	97
Pulford	.73	1.39	2.12	51=	105=	93=	9.29	11.41	19	31
Ash Magna	.24	1.88	2.12	95=	85=	93=	1.00	3.12	83=	98
Knightley	.73	1.39	2.12	51=	105=	93=	.26	2.38	138=	125
Gallantry Bank	.24	1.75	1.99	95=	89	96	.74	2.73	124=	110=
Winterley	.97	.99	1.96	46=	141=	97	.52	2.48	130=	118=
Rodington	.48	1.40	1.88	58=	94=	98=	6.99	8.67	25	37
Norton in Hales	.48	1.40	1.88	58=	94=	98=	6.32	8.20	29	38
Tibberton	.48	1.40	1.88	58=	94=	98=	5.94	7.82	34	43
Hadnall	.48	1.40	1.88	58=	94=	98=	4.87	6.75	42	50
Blymhill	.48	1.40	1.88	58=	94=	98=	4.13	6.01	48	57
Tilstock	.48	1.40	1.88	58=	94=	/98=	3.56	5.43	59	63
Church Minshull	.48	1.40	1.88	58=	94=	98=	3.17	5.05	64	68
Childs Ercall	.48	1.40	1.88	58=	94=	98=	1.00	2.88	83=	102=
Preston Weald Moors	.48	1.40	1.88	58=	94=	98=	.26	2.13	138=	133=
Acton	.48	1.40	1.88	58=	94=	98=	1.00	2.88	83=	102=
Moreton Corbet		1.86	1.86	160=	86	108	1.00	2.86	83=	104
Whixall		1.83	1.83	160=	88	109	1.26	3.09	75=	100
Burleydam	.24	1.52	1.76	95=	90=	110=	.26	2.02	138=	135=
Knighton (Maer)	.24	1.52	1.76	95=	90=	110=	1.00	2.76	83=	106=
Grinshill	.24	1.52	1.76	95=	90=	110=	4.23	5.98	46	58
Derrington	.73	.99	1.72	51=	141=	113=	5.22	6.94	41	49
Stanton u Hine Heath	.24	1.39	1.63	95=	105=	114=	6.15	7.78	31=	44
Lilleshall	.24	1.39	1.63	95=	105=	114=	5.73	7.36	36	46
Yarnfield	.24	1.39	1.63	95=	105=	114=	4.41	6.04	43	56
Aston (Maer)	.24	1.39	1.63	95=	105=	114=	3.51	5.14	60	66
Norbury (Staffs)	.24	1.39	1.63	95=	105=	114=	1.57	3.20	72	96

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Keele	.24	1.39	1.63	95=	105=	114=	1.00	2.63	83=	112=
Faddiley	.24	1.39	1.63	95=	105=	114=	1.00	2.63	83=	112=
Chebsey	.24	1.39	1.63	95=	105=	114=	1.00	2.63	83=	112=
Upton Magna	.24	1.39	1.63	95=	105=	114=	8.93	10.56	22	32
Ightfield	.24	1.39	1.63	95=	105=	114=	.26	1.89	138=	147=
Crudginton	.24	1.39	1.63	95=	105=	114=	.26	1.89	138=	147=
Hyde Lea	.24	1.39	1.63	95=	105=	114=	.26	1.89	138=	147=
Little Madeley	.24	1.39	1.63	95=	105=	114=	.26	1.89	138=	147=
Calverhall	.48	1.00	1.48	58=	135=	128=	6.27	7.75	30	40
Sound	.48	1.00	1.48	58=	135=	128=	1.00	2.48	83=	118=
Hatherton	.48	1.00	1.48	58=	135=	128=	1.00	2.48	83=	118=
Bradley	.48	1.00	1.48	58=	135=	128=	.26	1.75	138=	152
Cold Hatton	.48	1.00	1.48	58=	135=	128=		1.48	168=	166=
Little Haywood	.48	1.00	1.48	58=	135=	128=		1.48	168=	166=
Adderley		1.40	1.40	160=	94=	134	1.00	2.48	83=	121
Stoke U Tern		1.39	1.39	160=	105=	135=	4.28	5.67	44=	62
Ranton		1.39	1.39	160=	105=	135=	2.05	3.44	69	92
Warmingham	.24	1.15	1.39	95=	134	135=	1.00	2.39	83=	123=
Great Bolas		1.39	1.39	160=	105=	135=	1.00	2.39	83=	123=
Hankelow		1.39	1.39	160=	105=	135=	.52	1.91	130=	145=
Aston		1.39	1.39	160=	105=	135=	.52	1.91	130=	145=
Preston Brockhurst		1.39	1.39	160=	105=	135=	.74	2.13	124=	133=
Adbaston		1.39	1.39	160=	105=	135=	.26	1.65	138=	155=
Sherrifhales		1.39	1.39	160=	105=	135=	.26	1.65	138=	155=
Stretton		1.39	1.39	160=	105=	135=	.26	1.65	138=	155=
High Offley	.48	.86	1.34	58=	171=	145=	.26	1.60	138=	160
Stapeley	.48	.86	1.34	58=	171=	145=		1.34	168=	170
Wardle	.73	.53	1.26	51=	179=	147		1.26	168=	171
Wistanwick	.24	.99	1.23	95=	141=	148=	3.83	5.06	53	67
Weston U Redcastle	.24	.99	1.23	95=	141=	148=	3.37	4.60	63	74
Acton Trussel	.24	.99	1.23	95=	141=	148=	2.68	3.92	67	86
Barthomley	.24	.99	1.23	95=	141=	148=	5.89	7.12	35	48
Norton Bridge	.24	.99	1.23	95=	141=	148=	1.26	2.49	75=	117
Withington	.24	.99	1.23	95=	141=	148=	1.00	2.23	83=	126=
Slindon	.24	.99	1.23	95=	141=	148=	1.00	2.23	83=	126=
High Onn	.24	.99	1.23	95=	141=	148=	.74	1.97	124=	144
Tixall	.24	.99	1.23	95=	141=	148=	.26	1.49	138=	162=
Hough	.24	.99	1.23	95=	141=	148=	.26	1.49	138=	162=
Prees Green	.24	.99	1.23	95=	141=	148=	.26	1.49	138=	162=
Balterley	.24	.99	1.23	95=	141=	148=	.26	1.49	138=	162=
Platt Lane	.24	.99	1.23	95=	141=	148=		1.23	168=	173=
Chorley	.24	.99	1.23	95=	141=	148=		1.23	168=	173=
Great Chatwell	.24	.99	1.23	95=	141=	148=		1.23	168=	173=
Milwich	.24	.94	1.18	95=	167=	163=	1.00	2.18	83=	131=
Bishops Offley	.24	.94	1.18	95=	167=	163=	1.00	2.18	83=	131=
Buerton	.24	.86	1.10	95=	171=	165	.26	1.36	138=	169
Maer	.24	.85	1.09	95=	174=	166=	5.51	6.61	37	51
Church Aston	.24	.85	1.09	95=	174=	166=	4.06	5.16	49=	64
Bradfield Green	.24	.85	1.09	95=	174=	166=	.52	1.61	130=	159
Admaston	.48	..54	1.02	58=	177=	169	1.00	2.02	83=	135=
Ellenhall		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Eyton U Weald Moors		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Kynnersley		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Moddershall		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Uffington		199	.99	160=	141=	170=	1.00	1.99	83=	137=
Whitgreave		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Wollerton		.99	.99	160=	141=	170=	1.00	1.99	83=	137=
Knighton		.99	.99	160=	141=	170=	.26	1.26	138=	171=

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Ellerdine Heath	.48	.46	.94	58=	182=	178=	1.26	2.20	75=	129=
Bunbury Heath		.94	.94	160=	167=	178=	1.26	2.20	75=	129=
Colwich	.48	.46	.94	58=	182=	178=	9.58	10.52	17	33
Sambrook		.94	.94	160=	167=	178=	3.84	4.78	52	72
Fradswell	.24	.53	.77	95=	179=	182	.26	1.04	138=	176
Lee Brockhurst	.24	.46	.70	95=	182=	183=	1.00	1.70	83=	153=
Poynton Green	.24	.46	.70	95=	182=	183=	1.00	1.70	83=	153=
Onneley	.24	.46	.70	95=	182=	183=	3.67	4.37	58	75=
Steel Heath	.24	.46	.70	95=	182=	183=		.70	168=	177
Hanchurch	.24	.45	.69	95=	188	187	4.18	4.88	47	70
Brindley	.24	.40	.64	95=	189=	188	1.00	1.64	83=	158
Gayton		.54	.54	160=	177=	189	1.00	1.54	83=	161
Moreton Say		.40	.40	160=	189=	190=	1.00	1.40	83=	168
Chapel Chorlton		.40	.40	160=	189=	190=	2.95	3.35	66	95

Table 3.2

The Matrix of Spearman's Rank Correlation Coefficients between twelve alternative rankings of the 34 largest settlements in the study area

		1	2	3	4	5	6	7	8	9	10	11	12
1	Food	-	.859	.898	.889	.919	.967	.824	.868	.810	.887	.960	.879
2	Clothing		-	.819	.768	.857	.857	.791	.806	.840	.895	.862	.804
3	Hardware			-	.896	.958	.961	.855	.874	.860	.884	.951	.859
4	"Other Retail"				-	.946	.945	.823	.843	.864	.847	.941	.876
5	Non Food					-	.976	.858	.874	.880	.907	.973	.880
6	Total Retail						-	.816	.887	.858	.899	.994	.902
7	Prof/Financial							-	.818	.867	.927	.830	.698
8	Personal Services								-	.781	.907	.907	.784
9	County Services									-	.927	.862	.803
10	All Services										-	.926	.789
11	Total (Overall)											-	.890
12	Population												-

All correlations are significant at the 0.1% level

12 x 12 matrix showing how every method of ranking compares with every other. A glance at this matrix shows that all correlations are positive and that all are high.

One of the more important correlations on this matrix, and one which we originally set out to test, is that between the ranking of settlements on the basis of their retail provision and ranking by service provision. Table 3.2 shows that there is substantial agreement between these two, with a coefficient of r= +0.899. A comparison of retail and service rankings with overall rankings give r values of 0.994 and 0.926 respectively. Since the retail and service rankings are equal components in the overall figure this suggests that the ranking of settlements on the basis of their retail provision is marginally preferable to a ranking on service attributes.

Within the retail group the"non-food" division correlates most strongly with the total, and it naturally correlates closely too with the overall retail plus service total. There is little variation within the services group, but private services correlate slightly less well with the total than do the other subdivisions. (Perhaps because this group contains only a limited number of functions).

The rank correlations between population and the other factors are always positive and high, but they do vary over a small range. Population ranking correlates most strongly with ranking on the basis of total retail provision, and least well, although still significantly, with professional and financial services.

For smaller settlements it was not possible to perform tests

of ranking correlation in the same way due to the lack of functional distinctiveness, and the prevalence of tied positions. It was however possible to compare the ranking of villages according to social activities represented with that based upon the combined retail and service provision. In this case $p = +0.493$ which is just significant at the one percent level. This degree of correlation is the principal justification for the inclusion of a social component alongside retail and service ones in assessing the centrality of small settlements.

We have seen that there is close correlation between the ranking of the 34 largest settlements by their different functional attributes. Table 3.3. indicates the way in which these functions correlate with each other. The size of the coefficients shows that all retail groups and service groups tend to be very closely associated in their occurrence. In other words, for any settlement, a high score on one retail or service group implies that all other groups will also score high. Again a certain amount of correlation between overlapping groups would be expected, but even the exclusive groups correlate strongly with all others. Table 3.3. is valuable in that it quantifies the associations between the various functional groups and because it indicates a high degree of correlation between retail and unrelated service functions. Tables 3.2 and 3.3 together show that although retail analyses are only a partial assessment of the centrality of an urban place they are also a good guide to total centrality; at least in the higher and middle ranges.

All functions are seen to correlate with variable No. 13 which is the distance from each settlement to its nearest neighbour.(i) Column 14 in Table 3.3 shows the correlation between each of the retail/service functions and the distance from each settlement to the nearest urban centre with more than 25,000 people. Without exception these coefficients are negative, but they are generally significant only between the one percent and 5 percent levels. The highest correlation in this column is

(i) Here defined as the nearest settlement of equal or larger population.

Table 3.3

Settlement Functions, Simple Correlation

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Food	-	91	96	91	93	95	89	88	86	90	94	85	71	42
2	Clothing		-	96	95	97	97	96	92	91	97	97	88	68	42
3	Hardware			-	98	99	99	95	93	89	96	98	86	77	39
4	Other Retail				-	99	99	97	92	89	96	99	87	79	44
5	Non-Food					-	99	98	92	90	97	99	88	77	43
6	Total Retail						-	97	93	90	97	99	89	77	43
7	Prof/Financial							-	92	94	99	98	93	74	44
8	Personal Services								-	88	95	94	84	71	44
9	County Services									-	96	92	92	56	44
10	All Services										-	96	93	71	45
11	Grand Total											-	90	76	44
12	Population												-	54	55
13	Dist. to Nearest Neighbour													-	11
14	Dist. to Nearest Settlement larger than 25,000 population														-

Significant @ 5% where $r > 0.35$

1% " $r > 0.45$

0.1% " $r > 0.55$

The decimal point has been moved two spaces to right

Underlined coefficients are negative

with population. The inverse relationships shown in column 14 serve as a further illustration of the way in which the development of small towns and villages is influenced by their proximity to a major centre.

Correlation between centrality and population size.

The relationship between centrality and the population of a settlement is a fundamental aspect of central place study, and it is evident that there is a direct relationship between the two variables. Thus ceteris paribus, the greater the population of a settlement, the greater its functional complexity will be.

Perhaps the most obvious facet of this correlation is the increasing range of facilities which are offered by increasingly large centres. Figure 3.1 shows that the relationship between population size and the number of shops possessed by settlements in the study area is log-linear for the 34 largest settlements. Certain clusters of centres may also be identified on this graph from prior knowledge – thus groups of market towns, dormitory villages and service villages have been provisionally outlined.

The nature of the population size/central functions relationship has been established by Berry B.J.[3] and O'Farrell[4] amongst others so comment here will be limited in the main to a broad expression of agreement with these two workers. Figure 3.1 was a preliminary mode of investigation in which the total number of shops was used as a crude measure of settlement rank. Perhaps a more significant measure is the total number of functional types which are represented in a centre. Thus in Figure 3.2 the total number of retail and service functions for each of the 191 settlements has been plotted against their population.

The relationship illustrated by Figure 3.2 is a curvi-linear one,

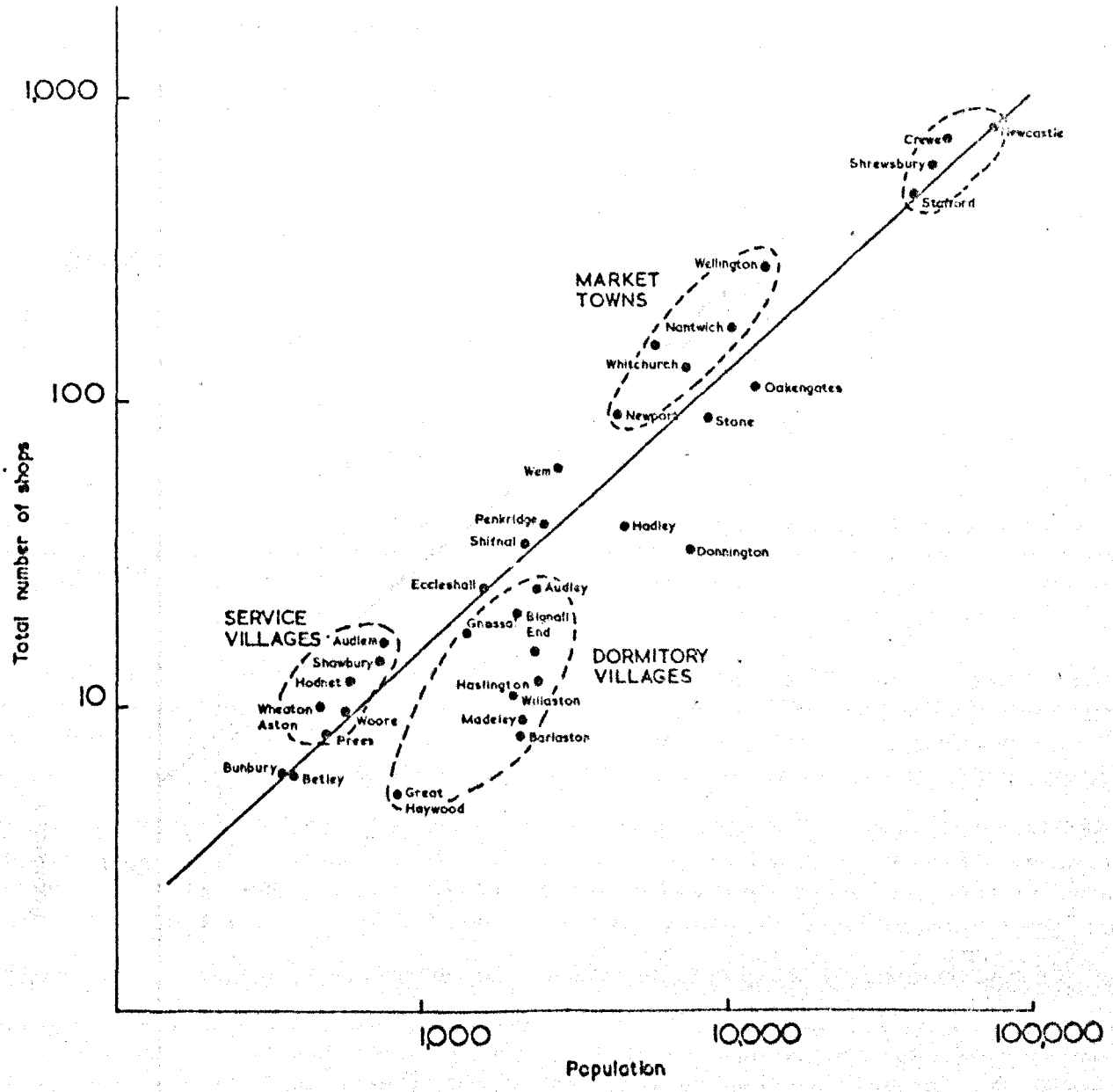

Figure 3.1 Relation between the number of shops and the population of settlements

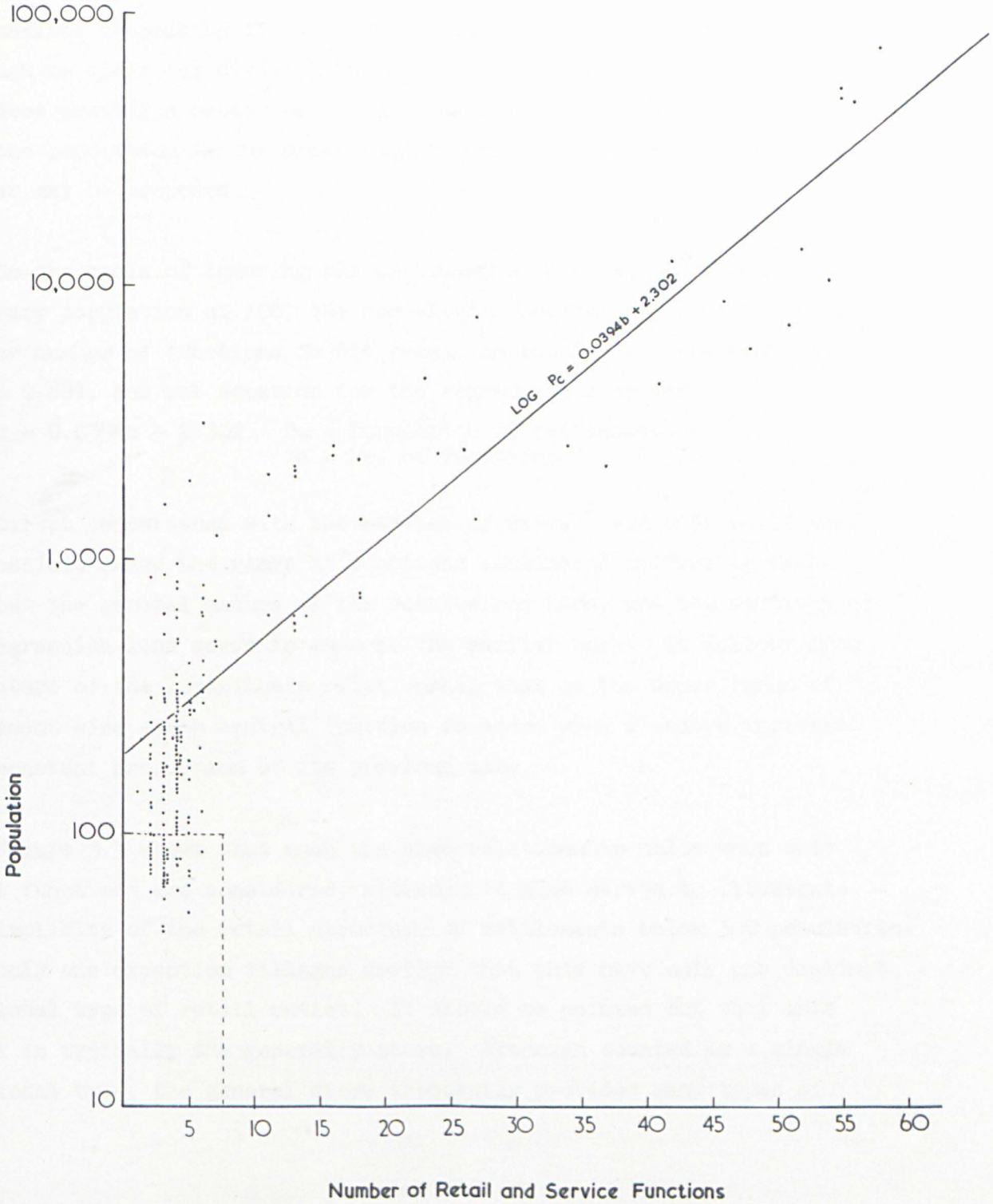

Figure 3.2 Relation between the number of retail and service functions and the population of settlements

with the linear form providing the best fit for the largest settlements. The relationship becomes non-linear, indeed one may suggest that it is dissociated from the population size, at the lowest level. Berry and O'Farrell independently suggest that two regimes can be recognised, with hamlets comprising the one, and all other centres the second. Although no clear cut division is evident in Figure 3.2 the regression line does provide a better basis for predicting the number of functions from the population in the upper ranges, consequently two nascent regimes may be proposed.

On the basis of ignoring all settlements below an admittedly arbitrary population of 100, the correlation between resident population and the number of functions in the remaining settlements was found to be $r = 0.884$, and the equation for the regression line was

$\log Pc = 0.0394b + 2.302$ Pc = Population of settlement
b = No. of functions

Direct comparisons with the studies of Berry [4] and O'Farrell[5] are not possible since the range of functions considered differs in each case but the general nature of the conclusions here, and the equation of the regression line serve to endorse the earlier work. It follows from the nature of the logarithmic relationship that in the upper range of settlement size a new central function is added when a centre increases by a constant proportion of its previous size.

Figure 3.3 shows that much the same relationship holds when only retail functions are considered, although it also serves to illustrate the simplicity of the retail structure of settlements below 300 population. With only one exception villages smaller than this have only one distinct functional type of retail outlet. It should be pointed out that this outlet is typically the generally store. Although counted as a single functional type, the general store frequently provides many types of

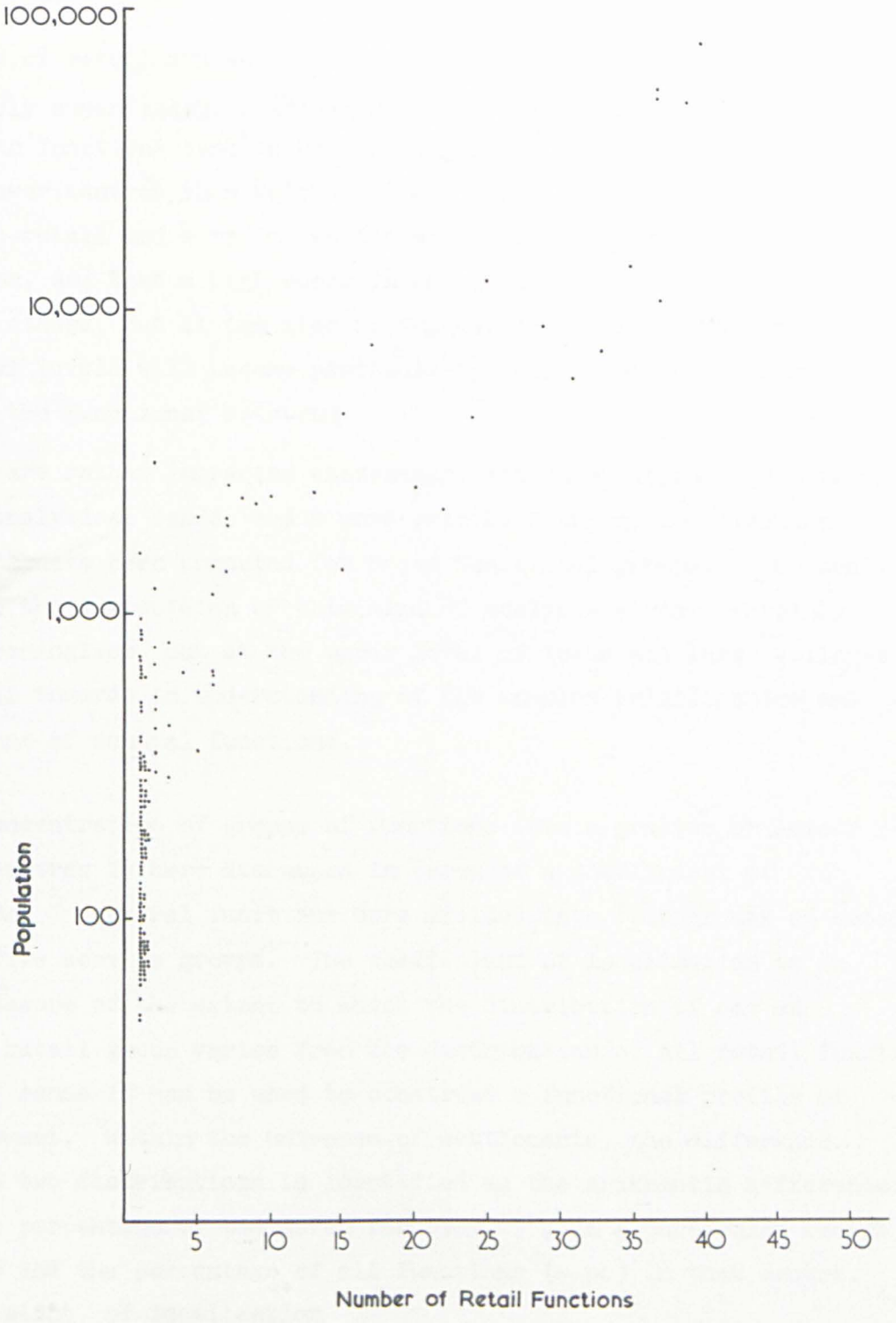

Figure 3.3 Relation between the number of retail functions and the population of settlements

goods but the emphasis is upon food, confectionery and tobacco. Below 300 population most villages achieve a degree of centrality through their provision of services (especially county services) rather than through their retail facilities.

The balance of retail and service facilities.

A fairly superficial examination of retail and service facilities reveals that certain functions tend to be more concentrated in their location, and occur in fewer centres than do other, more dispersed functions. Table 3.3 showed that retail and service functions are closely correlated in their distribution, and that a high score in one group implies a high score in all of the others, but it can also be suggested that towns at different hierarchical levels will become particularly well developed in certain sectors of the functional spectrum.

These are rather imprecise statements, and in an attempt to give them a sounder analytical basis, and a more precise meaning, localisation coefficients have been computed for broad functional groups. For smaller settlements the imprecision of this kind of analysis almost certainly makes it meaningless, but at the upper level of towns and large villages it does help towards an understanding of the complex relationships and distributions of central functions.

The concentration of groups of functions into a greater or lesser number of centres is here discussed in terms of a coefficient of localisation.[5] Central functions were divided into four groups of retail types and five service groups. The coefficient of localisation is in effect a measure of the extent to which the distribution of say an individual retail group varies from the distribution of all retail functions, and in this sense it can be used to construct a functional profile of each settlement. Within the universe of settlements, the difference between the two distributions is identified as the arithmetic difference between the percentage of the given function "j", in a particular centre "c" (= pjc) and the percentage of all functions (= pc) in that centre. The coefficient of localisation

is then calculated by the formula :-

$$\frac{{}^{1}/_{2} \sum_{c}^{o} (pjc - pc)}{100}$$

In practise it is quicker to sum all of the positive (or negative) differences, rather than calculating the absolute sum of differences then halving it, for the result will be the same by either method, the positive and negative differences cancelling each other.

The limits of the coefficient are 0 and 1. If the given function is distributed in exactly the same way as all functions, the value of the coefficient will be zero. If complete concentration occurs in one centre the value will be unity.

In the present exercise retail functions were grouped into (1) food (2) clothing (including footwear) (3) household goods (hardware, furniture and electrical goods) (4) others. Banks, doctors, solicitors, primary schools and secondary schools were chosen to represent the service sector, but the method could be used for a wide range of functions.

Table 3.4 shows the tabulations upon which the coefficients of localisation were based. The functions in the whole settlement (i.e not just the central area) have been considered in each case. The values of the coefficients calculated were as follows:-

Table 3.5

1.	Solicitors	0.372	6.	Clothing stores	0.122
2.	Secondary schools	0.350	7.	Household goods	0.116
3.	Banks	0.320	8.	Other retail	0.084
4.	Primary schools	0.266	9.	Food	0.073
5.	Doctors	0.260			

Solicitors and secondary schools show the highest degree of

Table 3.4 The Percentages of Selected Retail and Service Establishments in each settlement, compared with the total distribution

(Positive deviations are underlined)

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Shrewsbury	13.66	12.70	11.84	14.28	17.38	11.85	10.63	14.05	25.75	7.32	11.76
Newcastle	18.13	17.78	20.07	15.44	19.03	9.22	8.51	8.64	12.01	12.6	19.11
Stafford	11.66	9.92	14.84	12.80	12.29	9.01	8.51	12.97	17.16	8.94	11.76
Crewe	17.06	15.96	19.33	18.43	16.78	7.44	9.57	10.8	9.44	8.54	11.76
Nantwich	4.04	4.09	4.24	3.82	3.90	3.85	7.45	3.78	5.58	1.62	4.42
Wellington	6.34	4.70	8.85	9.97	5.55	4.76	5.32	3.78	8.15	3.66	7.35
Whitchurch	2.99	2.14	3.50	4.98	3.31	2.58	4.26	3.24	3.43	0.81	2.94
Market Drayton	3.50	2.93	4.24	3.82	4.02	2.58	5.32	2.16	3.43	0.81	1.47
Oakengates	2.54	3.17	1.87	1.33	2.48	2.53	4.25	3.24	4.29	2.44	2.94
Stone	2.04	1.86	1.87	2.49	2.36	1.92	5.32	2.70	1.29	1.63	2.94
Newport	2.09	2.18	1.74	1.83	2.36	2.43	3.19	2.70	2.58	1.22	4.41
Shifnal	0.82	.70	.75	.99	1.06	1.22	3.19	1.62	.86	.81	1.47
Wem	1.39	1.07	1.99	1.50	1.54	1.52	2.13	2.16	1.72	1.22	2.94
Donnington	1.05	1.3	.75	.83	.83	.91	2.13	1.62		.81	
Hadley	.64	.65	.25	.99	.71	.56		1.08		.81	1.47
Penkridge	.70	.74	.25	.99	.83	.86	2.13	1.08	.43	.81	1.47
Eccleshall	.59	.56	.62	.83	.47	1.06	2.13	1.62	1.72	.41	1.47
Audley	.59	.65	.25	.66	.71	.91	1.06	1.08	0.86	.81	1.47
Gnossal	.34	.42	.25	.33	.24	.71	1.06	1.08		.81	1.47
Shavington	.32	.23	.25	.17	.71	.46				.41	
Bignall End	.50	.61		.99	.35	.20				.41	
Audlem	.25	.28	.25	.17	.24	.61	2.13	.54		.41	1.47
Shawbury	.25	.23	.25	.50	.12	.61	1.06	1.62		.81	
Willaston	.25	.37		.17	.24	.30		.54		.41	
Woore	.20	.28	.25	.17	.12	.35	1.06			.41	
Madeley	.20	.23	.25	.17	.12	.56	1.06	.54		.41	1.47
Haslington	.27	.32	.25	.33	.12	.46	1.06	1.08		.41	
Great Haywood	.20	.28	.12		.24	.51		1.08		.81	
Barlaston	.18	.19	.12		.35	.46		1.08	.43	.41	
Hodnet	.20	.23	.12	.17	.24	.46	1.06	1.62		.41	
Wheaton Aston	.20	.28	.25	.17		.25		.54		.41	
Betley	.14	.14		.17	.24	.51	1.06	1.62		.41	

Table 3.4 (cont'd..)

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Bunbury	.16	.23		.17	.12	.51	2.13	.54		.41	
Prees	.16	.19	.12	.17	.12	.41	1.06	.54		.41	
Wistaston	.11	.23				.51		1.08		.41	
Hixon	.09	.14	.12			.35		.54		.41	1.47
Halmer End	.16	.28		.17		.15					
Wrenbury	.09	.14	.12			.30	1.06	.54		.41	
Ashley	.05	.09				.30				.41	
Loggerheads	.02	.05				.25					1.47
Edgmond	.09	.14			.12	.25				.41	
Weston-u-Lizard	.05	.09				.30		.54		.41	
Hinstock	.05	.05			.12	.25				.41	
Weston (Crewe)	.05	.09				.30		.54	.43	.41	
Haughton(Stafford)	.07	.09			.12	.15					
Weston-u-Trent	.05	.09				.25			.43		
Woodseaves	.05	.09				.25				.41	
Tittensor	.05	.09				.25				.41	
Swynnerton	.02	.05				.25				.41	
Wrockwardine	.02	.05				.25				.41	
Blythe Bridge	.07	.14				.15					
Alsagers Bank	.11	.19			.12	.10					
Worleston						.25				.41	
Milford	.07	.09			.12	.15					
High Ercall	.02	.05				.25		.54		.41	
Cheswardine	.09	.14			.12	.15				.41	
Bromstead Heath	.07	.14				.20				.41	
Sandon	.05	.09				.10		.54		.41	
Walton	.05	.09				.20				.41	
Alpraham	.09	.19				.15					
Church Eaton	.02	.05				.20				.41	
Wood Lane	.11	.23				.15				.41	
Oulton	.05	.09				.20				.41	
Hilderstone	.05	.09				.20				.41	

Table 3.4 (cont'd..)

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Whitmore						.20					
Broeton	.07	.14				.15					
Clive	.05	.09				.25		1.08		.41	
Cotes Heath	.02	.05				.20				.41	
Croxton	.02	.05				.20				.41	
Great Bridgeford	.05	.09				.15					
Prees Higher Heath	.05	.09				.15					
Dunston						.20				.41	
Gailey						.20				.41	
Albrighton	.02	.05				.20					
Hales	.02	.05				.20				.41	
Seighford	.02	.05				.25				.41	
Mucklestone	.02	.05				.20				.41	
Standon	.02	.05				.15					
Bulkley	.02	.05				.15					
Hopton	.02	.05				.15					
Baldwins Gate	.09	.19				.15		.54			
Waters' Upton	.05	.09				.20		.54		.41	
Spurstowe	.02	.05				.10				.41	
Loppington	.05	.09				.15	1.06				
Wetwood	.05	.09				.15					
Wybunbury	.09	.19				.15				.41	
Cholmondley						.20				.41	
Stowe-by-Chartley	.05	.09				.15				.41	
Tong Norton						.15					
Miles Green	.11	.19			.12	.05					
Tern Hill						.15				.41	
Marbury-c-Quoisley	.02	.05				.20		.54		.41	
Fulford	.02	.05				.15				.41	
Ash Magna	.02	.05				.15					
Knightley	.07	.14				.15				.41	
Gallantry Bank	.02	.05				.15				.41	

Table 3.4 (cont'd..)

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Winterley	.09	.19				.10					
Rodington	.05	.09				.15				.41	
Norton in Hales	.05	.09				.15				.41	
Tibberton	.05	.09				.15				.41	
Hadnall	.05	.09				.15				.41	
Blymhill	.05	.09				.15				.41	
Tilstock	.05	.09				.15				.41	
Church Minshull	.05	.09				.15				.41	
Childs Ercall	.05	.09				.15				.41	
Preston Weald Moor	.05	.09				.15				.41	
Acton	.05	.09				.15				.41	
Moreton Corbet						.15					
Whixall						.15					
Burleydam	.02	.05				.15		.54			
Knighton (Maer)	.02	.05				.15		.54			
Grinshill						.15				.41	
Derrington	.07	.14				.10					
Stanton-u-Hine Hth	.02	.05				.15				.41	
Lilleshall	.02	.05				.15				.41	
Yarnfield	.02	.05				.15				.41	
Aston (Maer)	.02	.05				.15				.41	
Norbury (Staffs)	.02	.05				.15				.41	
Keele	.02	.05				.15				.41	
Faddiley	.02	.05				.15				.41	
Chebsey	.02	.05				.15				.41	
Upton Magna	.02	.05				.15				.41	
Ightfield	.02	.05				.15				.41	
Crudgington	.02	.05				.15				.41	
Hyde Lea	.02	.05				.15				.41	
Bednall	.02	.05				.15				.41	
Little Madeley	.02	.05				.15				.41	
Calverhall	.05	.09				.10					

Table 3.4 (cont'd..)

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Sound	.05	.09				.10					
Hatherton	.05	.09				.10					
Bradley	.05	.09				.10					
Cold Hatton	.05	.09				.10					
Little Haywood	.05	.09				.10					
Adderley						.15				.41	
Stoke-u-Tern						.05				.41	
Ranton						.15				.41	
Warmingham	.02	.05				.15				.41	
Great Bolas						.15				.41	
Hankelow						.15				.41	
Aston						.15				.41	
Preston Brockhurst						.15				.41	
Adbaston						.15				.41	
Sherrifhales						.20				.41	
Stretton						.15				.41	
High Ottley	.05	.09				.10				.41	
Stapeley	.05	.09				.15				.41	
Wardle	.07	.14				.05					
Wistanwick	.02	.05				.10					
Weston-u-Redcastle	.02	.05				.10					
Acton Trussel	.02	.05				.10					
Barthomley	.02	.05				.10					
Norton Bridge	.02	.05				.10					
Withington	.02	.05				.10					
Slindon	.02	.05				.15					
High Onn	.02	.05				.10					
Tixall	.02	.05				.10					
Hough	.02	.05				.10					
Prees Green	.02	.05				.10					
Balterley	.02	.05				.05					
Platt Lane	.02	.05				.10					

	% Total Retail Establishments	% Food Establishments	% Clothing & Footwear	% Household Goods	% Other	% Services Total	% Banks	% Doctors	% Solicitors	% 1° Schools	% 2° Schools
Chorley	.02	.05				.10					
Great Chatwell	.02	.05				.10					
Milwich	.02	.05				.10				.41	
Bishops Offley	.02	.05				.10				.41	
Buerton	.02	.05				.10					
Maer	.02	.05				.10				.41	
Church Aston	.02	.05				.10					
Bradfield Green	.02	.05				.10				.41	
Admaston	.05	.09				.05					
Ellenhall						.10					
Eyton upon Weald Moor						.10					
Kynnersley						.10					
Moddershall						.10					
Uffington						.10					
Whitgreave						.10					
Wollerton						.10					
Knighton						.10					
Ellerdine Heath	.05	.09				.05					
Bunbury Heath						.10				.41	
Colwich	.05	.09				.05					
Sambrook						.15				.41	
Fradswell	.02	.05				.05					
Lee Brockhurst	.02	.05				.05					
Poynton	.02	.05				.05					
Onneley	.02	.05				.05					
Steel Heath	.02	.05				.10					
Hanchurch	.02	.05				.05					
Brindley	.02	.05				.05					
Gayton						.05					
Moreton Say						.05				.41	
Chapel Chorlton						.10					
Dispersed	1.09	2.23				3.95		1.08		2.44	

concentration from this short list, with coefficients of 0.372 and .350 respectively, followed closely by banks at 0.320. The coefficients are relatively small, but it should be remembered that we are effectively measuring the concentration of functions not in one centre, but in a group comprising the dozen or so larger centres in the universe of settlements. Of the nine functions studied in this way food shops were, predictably, the least concentrated in their mode of occurrence. The "sump group" of "other retail" establishments had a coefficient of 0.084 showing marked similarity in distribution with the overall pattern, but household goods and clothing with coefficients of 0.116 and 0.122 were more concentrated. This variation in the coefficients of localisation illustrates the ubiquity of the general food store, and it shows that there are higher order goods and services such as clothing shops, banks and solicitors which cluster together in a few large centres. At a more specialised level of enquiry the coefficients for shops dealing in photographic equipment and those providing office furniture are 0.446 and 0.683 respectively.

Table 3.4 also reveals structural differences between the composition of the retail and service provision of the different centres. For example most of the larger centres show positive deviations in the clothing and footwear, household goods and 'other' retail sectors, and a deficit in food. In one or two cases there are positive loadings on food — e.g. Nantwich, and Oakengates, but this can be explained by the fact that these towns are overshadowed by more important neighbours. These positive loadings are an expression of the balance of different functional types within each town; i.e. a positive deviation in one sector indicates that a town has more

establishments of that type than it would have if the members of that sector were distributed in the same way as the overall pattern.

Of the urban centres, Shrewsbury, Newcastle, Crewe, Stafford, Wellington, Whitchurch, Market Drayton, Stone and Wem show positive loadings on at least two of the three non-food retail sectors. A few of the larger villages show positive deviations on non-food groups, explained by the provision of village drapers/clothing shops or hardware stores. Examples of this group are Shifnal, Penkridge, Hadley, Eccleshall, Audley, Shawbury, Woore etc. The commonest pattern however was for the smaller villages to show a small positive loading on food establishments and primary schools, and a deficit (not tabulated) in all other sectors.

Figures 3.4 and 3.5 show the spatial pattern of centres with positive loadings on various retail and service sectors. In 3.4 the circles which represent centres of different orders have been split into four sectors, food, clothing, hardware and other retail; where a centre has a positive deviation in one or more of these sectors the circle is shaded appropriately. Of the urban centres only Oakengates has a positive deviation in the food sector and the other towns most frequently have deviations in the other three divisions.

Figure 3.5 shows that there are many more centres with positive loadings in service sectors than there are for retail groups, and it has already been noted that many of the smaller settlements owe much of their centrality to their provision of services. In most of the minor (i.e. grade 6, 5 and 7) centres on this map however the deviations in the 'bank' sector for places such as Woore, Hodnet and Shawbury are accounted for by a single establishment. It is for this reason that centres have been shown by their hierarchical grade (i), obviously a one percent deviation in any

(i) Defined here by the progressive grouping method described in chapter 6.

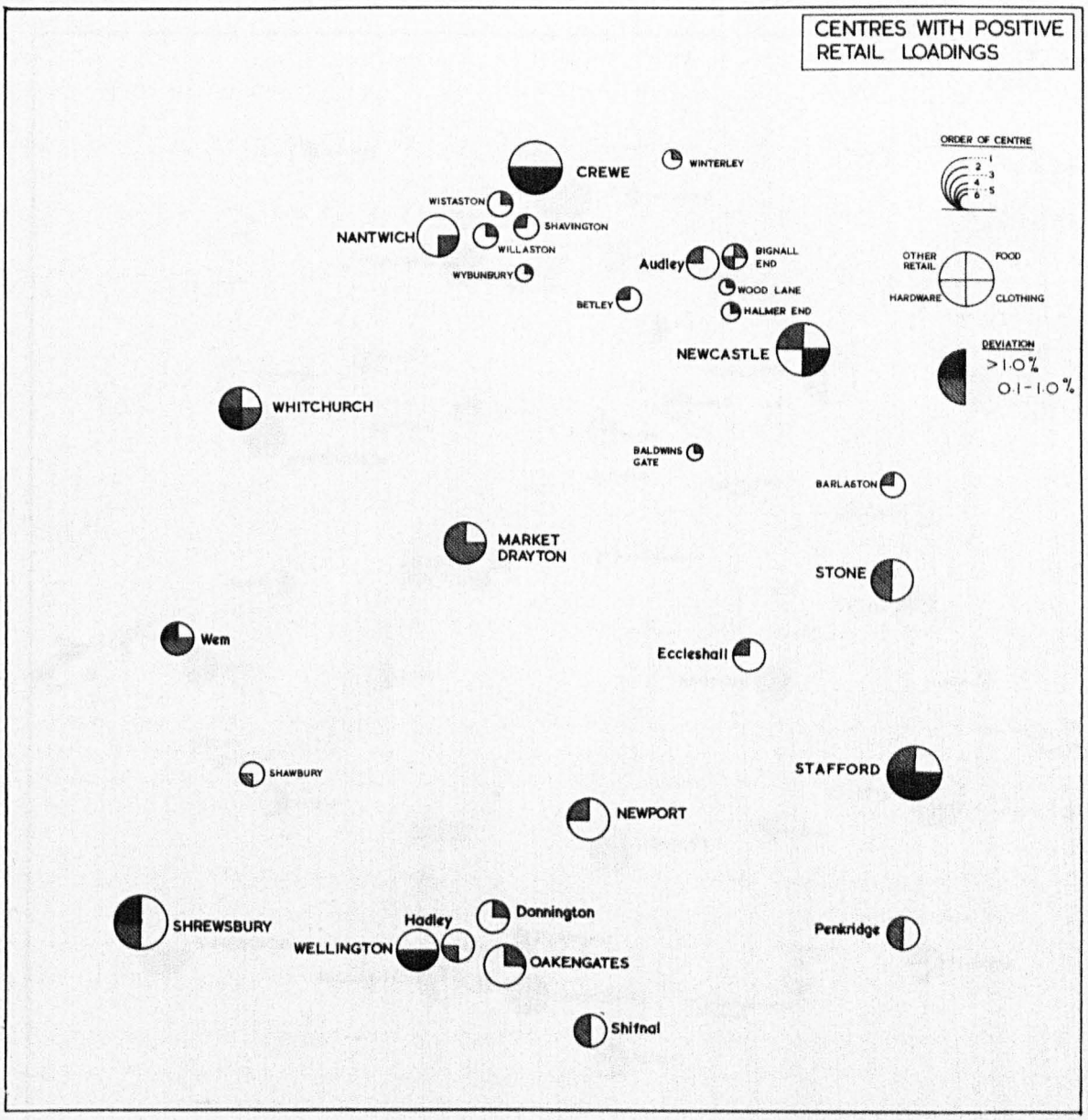

Figure 3.4 Centres with positive retail loadings

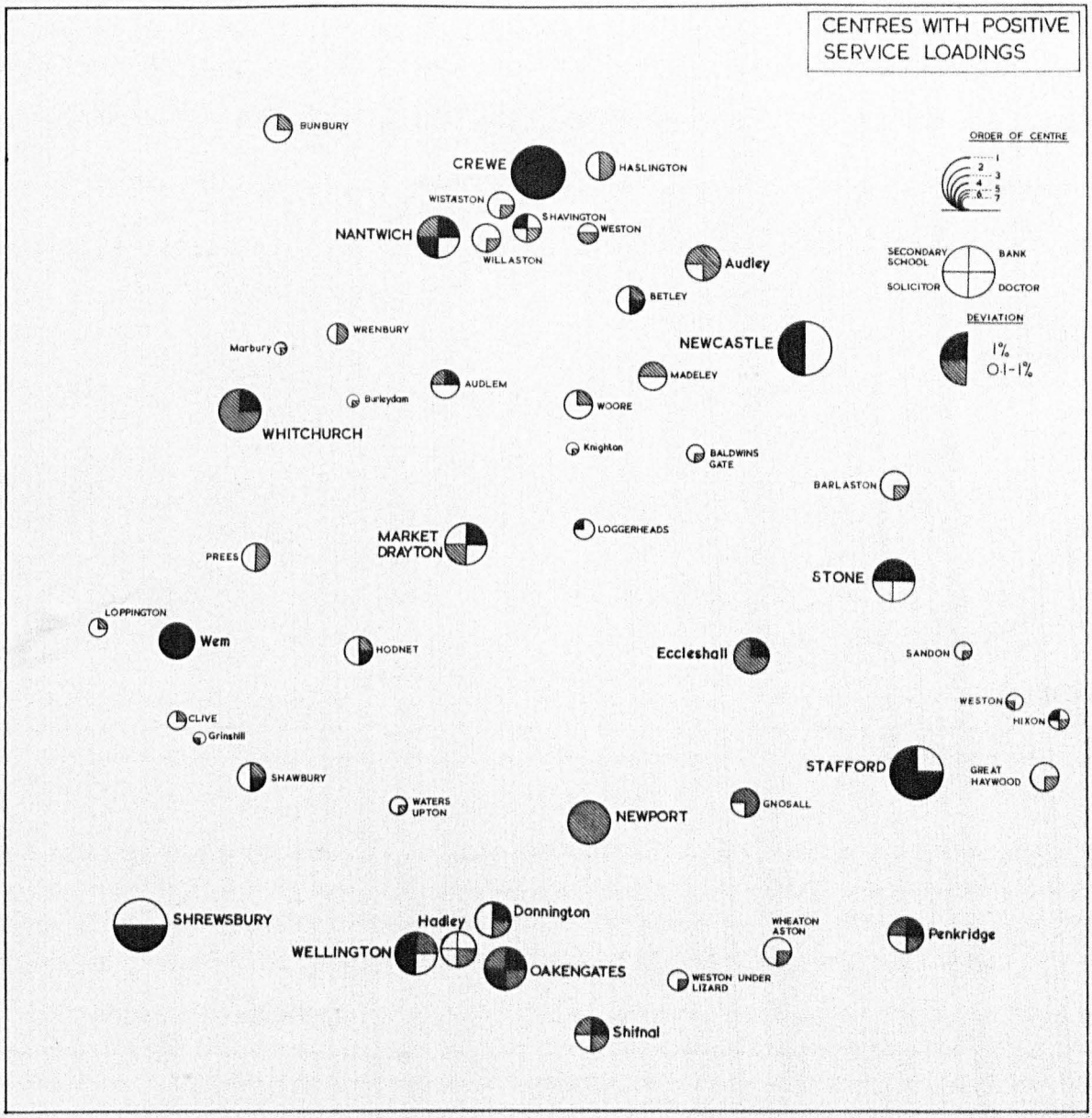

Figure 3.5 Centres with positive service loadings

sector is larger in absolute terms for a grade 1 centre than for a grade 6 settlement.

It is not legitimate to make direct comparisons between centres from these figures. Thus it would be wrong to conclude for instance that because Stafford has a positive deviation in the clothing sector, it has better shopping facilities of this kind than does Shrewsbury which shows no such positive loading. Rather the figures are a comment upon the structure of retail and service facilities in each centre and in the above context it would be possible to say that Stafford has a greater provision of clothing stores than one would expect from its total number of retail establishments.

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Chapter 4 - Alternative approaches to the measurement of centrality.

The previous chapter examined in some detail the incidence of a broad range of retail, service and social functions in different centres, and the way in which these can be used to measure a settlement's total functional status. It is instructive however to approach the measurement of centrality from several alternative directions, since each direction will illuminate a different aspect of a settlement's total centrality. This chapter examines alternative functions and functional relationships, but it should be pointed out at an early stage that many of the approaches discussed prove to be unsatisfactory analytical tests, (at least in the context of the present study), and that to some extent the conclusions reached are negative ones.

Alternative retail measures.

Measures of centrality based upon some aspect of retail business figure prominently —indeed dominantly —in most central place studies, and the reasons for this are fairly clear. Retail functions are relatively easy to measure, they are widely distributed in settlements of all sizes, and since retail establishments are visited by the general public as consumers more frequently, and more consistently than commercial or professional establishments, they must form the most important element of a town's centrality in relation to its hinterland.

Retail functions were examined by means of a location coefficient in chapter 3, and in terms of functional surplus and deficit later in this chapter, but other approaches have been tried by a number of other workers and R.L. Davies [1] has recently

compared alternative measures of retail centrality and attractiveness in shopping models. One of the primary difficulties in merely using the number of retail units is that shops vary in size, quality, variety of stock etc: hence different workers have tried to develop refinements which break away from a crude counting of shop units. Davies [2] however suggests that at many levels of enquiry the collection and processing of extensive functional data, and its subsequent use in sophisticated measures of centrality presents few advantages of accuracy over more straightforward measures. Additionally Davies W.K.D.[3] has shown a close correlation (Spearman Rank Correlation Coefficient = +0.99) in the Rhondda between centrality values based upon simple shop numbers and those calculated from data weighted by the number of assistants.

Berry [4] has suggested that the number of different business types which occur in a settlement identify the centre's status more accurately than the number of business establishments. In short, variety of provision is more diagnostic than volume. Fig. 4.1 shows the relationship between the number of establishments and the number of distinct retail functions for all the settlements in the study area, and it can be seen that the relationship is far from simple. At the lowest level on fig. 4.1 the relationship is virtually meaningless, for at this level many settlements possess only a single retail establishment, represented by a general store performing several different, although not necessarily distinct or obvious, functions. At high levels the functional breadth of the retail provision increases only slowly with increasing size (measured by number of establishments). Thus

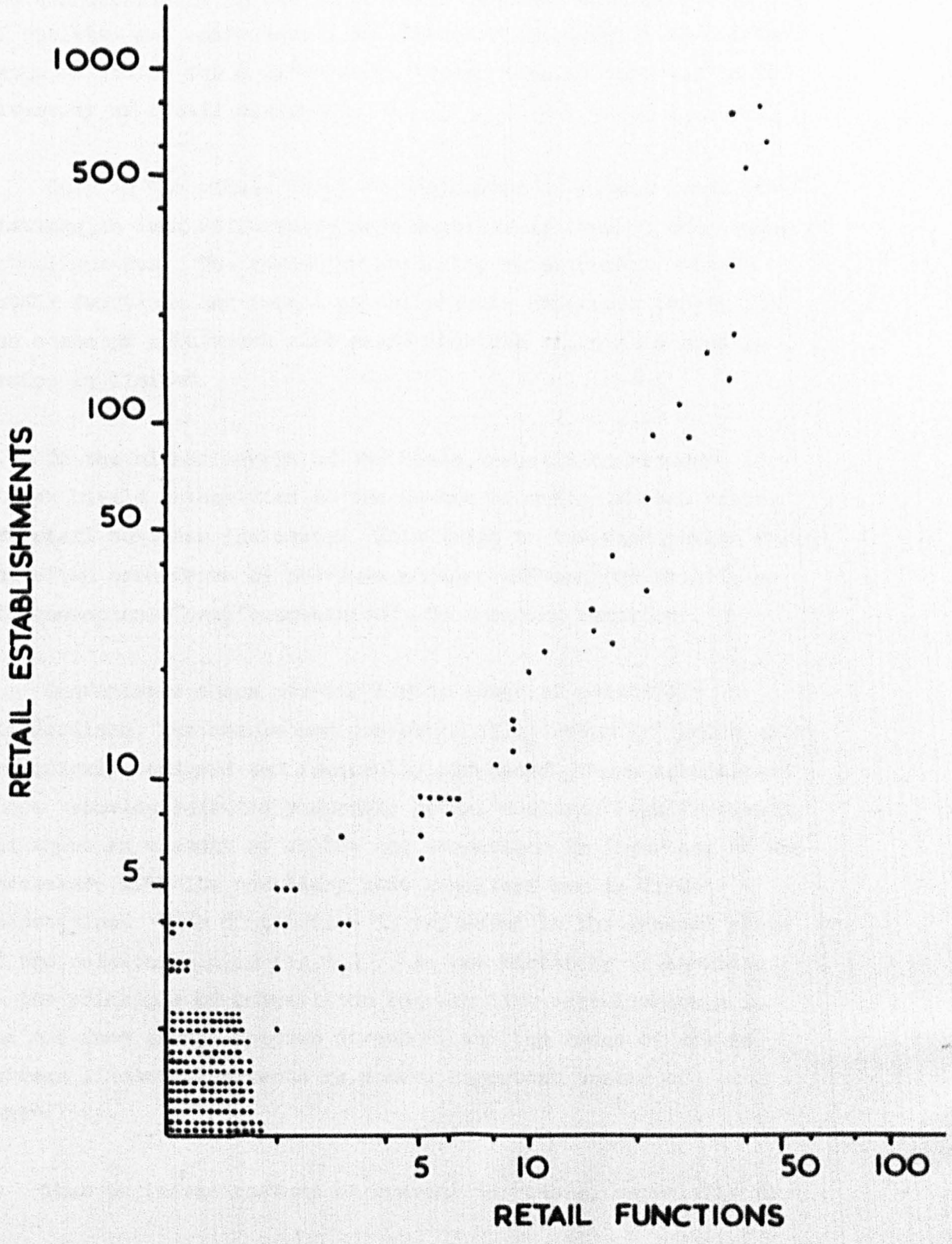

Figure 4.1 Relation between the number of retail functions and the number of retail establishments

the characteristic of the upper level centres is a multiplication of outlets, and consequently an increase in competition and the range of choice for a given good, rather than an increase in the diversity of retail equipment.

Only in the middle order do the number of retail functions distinguish rank differences more sensitively than do the number of establishments. The variation which the relationship between retail functions and retail establishments undergoes throughout the scale of settlement size means that its value as a grading device is limited.

In the higher levels of the scale, competition between direct rivals intensifies as the number of units in each branch of retail business increases. This leads to the distinction which has often been drawn by previous workers between the principles of "convenience" and "competition" in shopping behaviour.

Convenience shops provide a wide range of relatively standardised, perishable and non-perishable 'everyday' goods which are quickly consumed and frequently purchased. More specialised shops provide relatively durable goods, required less frequently and where an element of choice and comparison is important to the purchaser, with its corollary that suppliers are in direct competition. This distinction is reflected in the general shape of the relationship in fig.4.1 . As the hierarchy is ascended so the principle of competition between like establishments in the non-food groups becomes stronger, and the range of choice between like establishments is a more important aspect of centrality.

Thus an infrastructure of convenience shops, especially food

and general stores is found throughout the range of settlement sizes and types, but it is only in the truly central places of substantial size that the specialised shops occur and multiply competitively. More precisely this statement should be reversed, i.e. it is largely the possession of specialised shops which give a settlement its centrality. As Boesch [5] points out "...the quality of services available in a locality defines its degree of centrality, while the quantity of services available is in general only a function of the number of people served".

The "convenience-versus-competitive" division has achieved widespread use in the procedures for planning new shopping development, and the principle can be applied to the problem of rank measurement. The most easily applied, and conveniently used division of the total retail structure is derived by equating food shops to 'convenience'trade, and non-food to the competitive, or durable sector, and this is useful despite its crudeness. This division dismisses the small centres catering only for day-to-day food requirements, and gives a proper emphasis to those centres with a higher proportion of specialised shops. Fig 4.2 shows the larger, more important centres to have relatively small sectors representing the food shops; if central shopping areas only were to be considered, the sectors would be proportionately still smaller.

Table 4.1 lists the larger centres in order of the percentage of non-food shops in the central area. A rudimentary index of retail centrality (R.C.) can be derived from this data, where

$$(R.C.) = \frac{\text{Total No. of Central Area shops} \times \% \text{ of non-food Central Area shops}}{100}$$

Column 3 of table 4.1 shows the index of Retail Centrality (R.C.)

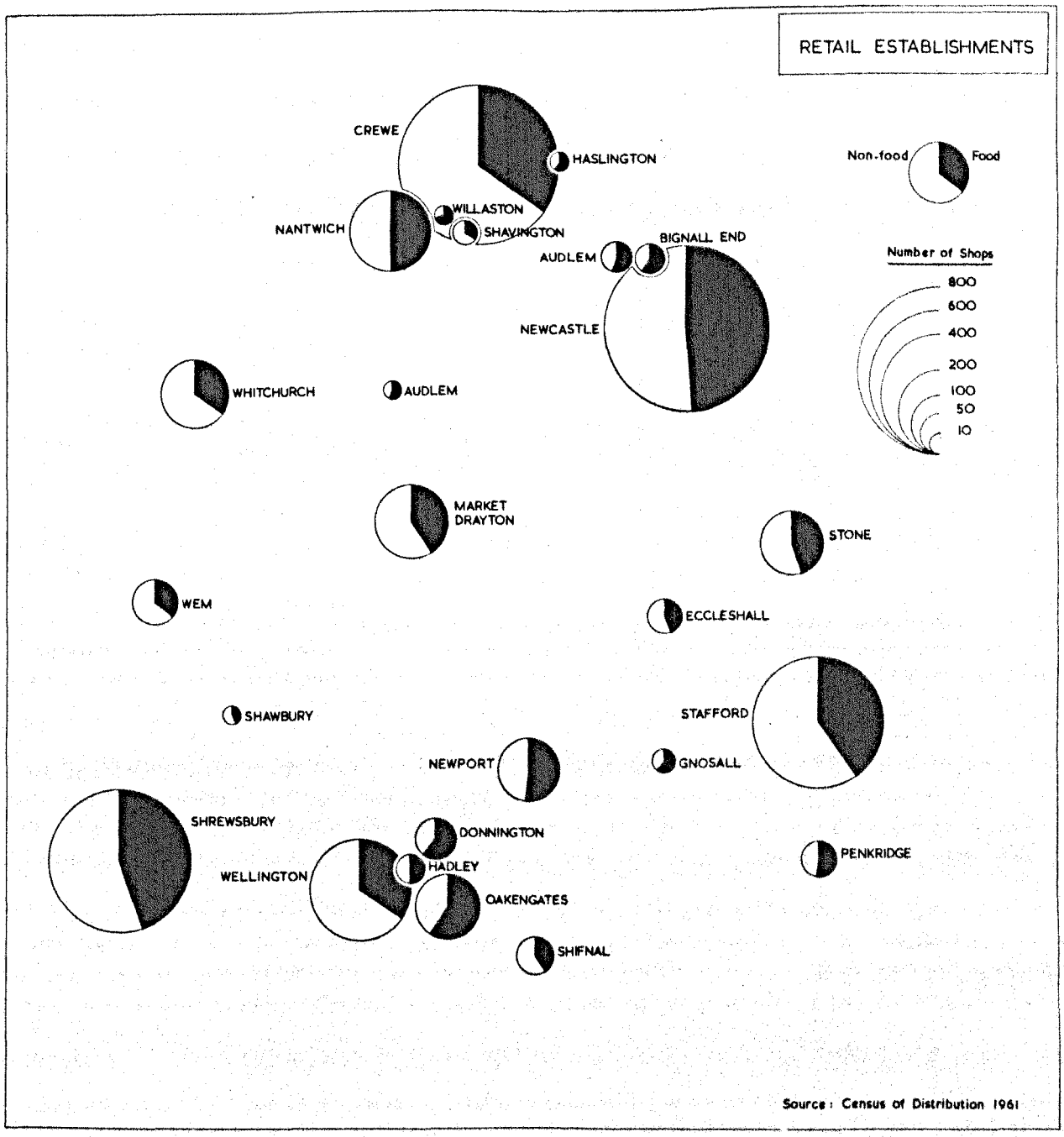

Figure 4.2 The total number of retail establishments in the main centres

Table 4.1 The Proportion of Non-Food shops and the Index of Retail Centrality (RC)

1	2	3	4	5
Town/Village	% Non-Food	Index of Retail Centrality (RC)	Rank	Rank by retail score from Table 3.1
Shrewsbury	85.4	233.14	1	1
Crewe	83.5	132.76	4	4
Stone	78.3	46.98	9	10
Wellington	78.1	89.82	6	6
Newcastle	77.7	149.96	3	3
Stafford	77.5	155.00	2	2
Nantwich	76.4	100.08	5	5
Oakengates	75.5	46.05	10	9
Whitchurch	72.8	74.98	7	7
Shifnal	71.8	24.41	13	13
Market Drayton	71.6	68.03	8	8
Newport	70.0	35.00	11	11
Shavington	64.3	9.00	19	20
Wem	60.5	26.01	12	12
Eccleshall	58.3	13.99	16	17
Shawbury	54.3	5.97	21	24
Hadley	53.8	13.98	17	15
Audley	52.2	12.00	18	18
Penkridge	50.0	15.00	15	16
Betley	50.0	3.00	25	32
Audlem	45.5	5.00	22	22
Hodnet	44.5	4.00	23	30
Madeley	44.5	4.00	23	27
Gnossal	43.0	6.02	20	21
Donnington	41.5	17.84	14	14

Spearman Rank Correlation coefficient between columns 4 and 5 is R = 0.949

calculated in this manner for each of the larger settlements, and it can be seen that the ranking of towns thus produced corresponds very closely to the rankings produced by the more sophisticated retail techniques in chapter 3. This index is not put forward as a definite or final measure of centrality, but in view of its great simplicity, and substantial agreement with more rigorous methods it can be considered a useful tool for the rapid assessment of retail centrality and ranking.

Functional Surplus and Deficit.

A slightly different view of the centrality of a settlement involves an assessment of the central functions it possesses in excess of some theoretical figure computed on the basis of its resident population. The assumption that a central place performs functions for a hinterland population is fundamental to the whole of central place study, and many workers have tried to isolate this external or hinterland element. For instance Ullman[6] suggested at an early date that centrality could be measured by calculating the functions which a town possessed in addition to those needed to meet its own immediate requirements.

In the present study an attempt has been made to compare the retail and service facilities possessed by towns and villages, with the facilities which they could theoretically be expected to provide purely on the basis of their size, measured by their resident populations. Thus the centrality values of all retail establishments and of all services have been summed, and a theoretical score has been calculated for the retail and service facilities provided in the whole area per thousand of the population. This notional

score was 9.48 retail points and 4.58 service points per thousand. The actual scores for each settlement were then compared with those theoretically expected and a difference (i.e. a surplus or a deficit) established. These are listed in Table 4.2.

Within the limits of the underlying assumption that each person in the area both requires and receives an identical standard of service provision, it is possible to suggest thatthe towns showing a surplus of points are providing retail and service facilities for consumers outside of their administrative boundaries. The surplus points could of course be expressed also in terms of their equivalence to a surplus, or external population, thus Shrewsbury's retail surplus of 235.15 points is equivalent to an additional population of 24,800 (235.15/9.48), but it was thought that the greatest practical value of the exercise was in establishing the relative positions of settlements on a scale of surpluses and deficits.

At first the differences between observed and expected scores for each settlement were expressed as standard deviations from the area, but this obscured the real scale of surpluses and deficits; in particular small departures from the mean for large settlements had their importance disguised.[7] To avoid losing the scale altogether whilst allowing a wide range of settlements to be considered the score differences for each centre were transformed logarithmically.

One constraint to be noted is that the allocation of 9.48 retail points and 4.58 service points per thousand of the population takes no account of how these points are made up. Thus although the figures are partially composed of points accruing from the highest order functions there is no suggestion that the smaller villages should posses these functions. Thus the expected scores calculated on the basis of each centre's resident population will be an over-estimate for the small settlements, and an under-estimate

Table 4.2 The functional surplus or deficit of main centres

	Retail Score			Log	Service Score			Log
	Observed	Expected	Difference	Diff.	Observed	Expected	Difference	Diff.
Shrewsbury	705.35	470.2	235.2	2.3711	259.67	227.2	32.5	1.5119
Newcastle	506.57	717.6	-211.0	2.3243	234.07	346.7	-112.6	2.0531
Stafford	543.32	453.1	90.2	1.9552	201.57	218.9	-7.3	0.8633
Crewe	368.46	504.3	-135.8	2.1335	183.70	243.6	-59.9	1.7774
Nantwich	322.15	98.6	223.5	2.3502	107.91	47.6	60.3	1.7803
Wellington	258.54	129.8	128.7	2.1106	123.84	62.7	61.1	1.7860
Whitchurch	235.83	68.2	167.6	2.2250	61.86	32.9	28.9	1.4609
Market Drayton	181.27	55.9	125.4	2.0969	78.70	27.0	51.7	1.7135
Oakengates	138.62	114.7	23.9	1.3784	79.80	55.4	24.4	1.3876
Stone	135.08	83.4	51.7	1.7135	61.52	40.3	21.2	1.3243
Newport	107.41	41.7	65.7	1.8176	71.30	20.2	51.1	1.7076
Shifnal	66.40	20.8	45.6	1.6890	30.65	10.1	20.6	1.3139
Wem	66.50	24.7	41.8	1.6212	30.38	11.9	18.5	1.2672
Donnington	60.13	73.5	-13.4	1.1271	18.17	35.5	-17.3	1.2355
Hadley	51.96	43.4	8.5	0.9294	11.02	20.9	-9.8	0.9912
Penkridge	44.67	23.70	20.9	1.3201	17.36	11.4	5.9	0.7709
Eccleshall	36.03	13.27	22.7	1.3560	21.42	6.4	14.9	1.1732
Audley	27.90	23.32	4.6	0.6628	26.18	11.27	14.9	1.1732
Gnosall	18.60	13.27	5.3	0.7243	14.71	6.4	8.3	0.9191
Shavington	23.44	22.08	1.3	0.1139	7.99	10.6	-2.6	0.4150
Bignall End	23.76	19.50	4.3	0.6335	5.67	9.4	-3.7	0.5682
Audlem	15.93	7.01	8.9	0.9494	13.22	3.39	9.8	0.9922
Shawbury	13.61	6.79	6.8	0.8325	11.70	3.28	8.4	0.9243
Willeston	14.74	18.70	-3.9	0.5911	4.92	9.0	-4.1	0.6128
Woore	10.53	5.88	4.7	0.6721	8.14	2.84	5.3	0.7243
Madeley	10.46	24.90	-14.4	1.1584	8.16	12.03	-3.9	0.5911
Haslington	10.79	22.9	-12.1	1.0828	6.50	11.1	-4.6	0.6628
Great Haywood	7.05	11.32	-4.3	0.6335	9.03	5.47	3.6	0.5563
Barleston	8.53	19.9	-11.3	1.0531	5.89	9.62	-3.7	0.5682
Hodnet	8.05	5.50	2.55	0.4065	6.16	2.65	3.5	0.5441
Wheaton Aston	10.25	13.7	-3.5	0.5441	3.16	6.62	-3.5	0.5441
Betley	5.85	5.27	0.6	$\bar{1}$.7782	7.02	2.55	4.5	0.6532
Bunbury	3.64	3.36	0.28	$\bar{1}$.4472	7.99	1.62	6.4	0.8062
Prees	5.39	5.88	-0.49	$\bar{1}$.6902	5.99	2.84	3.2	0.5081
Wisteston	1.21	29.8	-28.56	1.4564	6.79	14.4	-7.6	0.8808
Hixon	1.28	5.87	-4.6	0.6628	5.48	2.84	2.6	0.4150
Malmer End	3.43	7.6	-4.2	0.6232	3.23	3.66	-0.4	$\bar{1}$.6021
Wrenbury	1.29	6.4	-5.1	0.7076	4.21	3.09	1.1	0.0414
Ashley	0.48	6.6	-6.1	0.7853	4.40	3.20	1.2	0.0792
Loggerheads	0.24	6.6	-6.4	0.8067	4.56	3.22	1.3	0.1139
Edgmond	1.29	11.49	-10.2	1.0086	3.50	5.5	-2.0	0.3010
Weston-u-Lizard	0.48	1.7	-1.2	0.0792	4.05	0.8	3.3	0.5185
Hinstock	0.90	4.6	-3.7	0.5682	3.53	2.2	1.3	0.1139
Weston (Crewe)	0.48	4.7	-4.2	0.6232	3.94	2.29	1.7	0.2304
Haughton	0.77	2.8	-2.0	0.3010	2.58	1.34	1.2	0.0792
Weston-u-Trent	0.48	3.5	-3.0	0.4771	3.53	1.71	1.8	0.2553
Woodseaves	0.48	6.0	-5.5	0.7404	3.51	2.90	0.6	$\bar{1}$.7782
Titensor	0.48	5.8	-5.3	0.7243	3.51	2.84	0.7	$\bar{1}$.8451
Swynnerton	0.24	1.1	-0.9	$\bar{1}$.9542	3.59	0.54	3.0	0.4771
Brockwardine	0.24	1.9	-1.7	0.2304	3.54	0.92	2.6	0.4150
Crewe/Nantwich	690.61	602.9	87.7	1.943	291.6	291.28	-	-

for the towns.

The functional surpluses and deficits of the 50 largest centres in the area have been plotted from Table 4.2 on to a graph, Figure 4.3. One axis represents surplus or deficit points on the retail scale and the other relates to services. The relationship between the retail and service provision of each centre and its resident population is illustrated by the centre's position relative to the two axes, but as previously suggested the similarity between towns in these respects is of more interest than their absolute positions.

Settlements have been grouped in Figure 4.3 on a simple nearest neighbour basis as an approach to determining a hierarchy of central places. As an approximation, centres could be ranked along an axis running from top right to bottom left, but this is far from being a simple line with a regular gradient. It is more valid in fact to use the figure as a means of identifying groups of settlements with similar functional surpluses and deficits. The anomalous position of undoubtedly important central places like Newcastle and Crewe, illustrates the limitations of equating centrality with the possession by a centre of facilities in addition to those "required" by its immediate residents.

The position of maximum centrality on the graph occurs in the top right hand corner where a surplus of both retail and service points is recorded. It is in this corner that most of the old-established market towns are placed, but there are also many large villages such as Eccleshall, Penkridge and Shawbury, which for the most part are relatively isolated centres serving as low order central places for rural areas of modest size. Settlements in this quarter have been grouped into

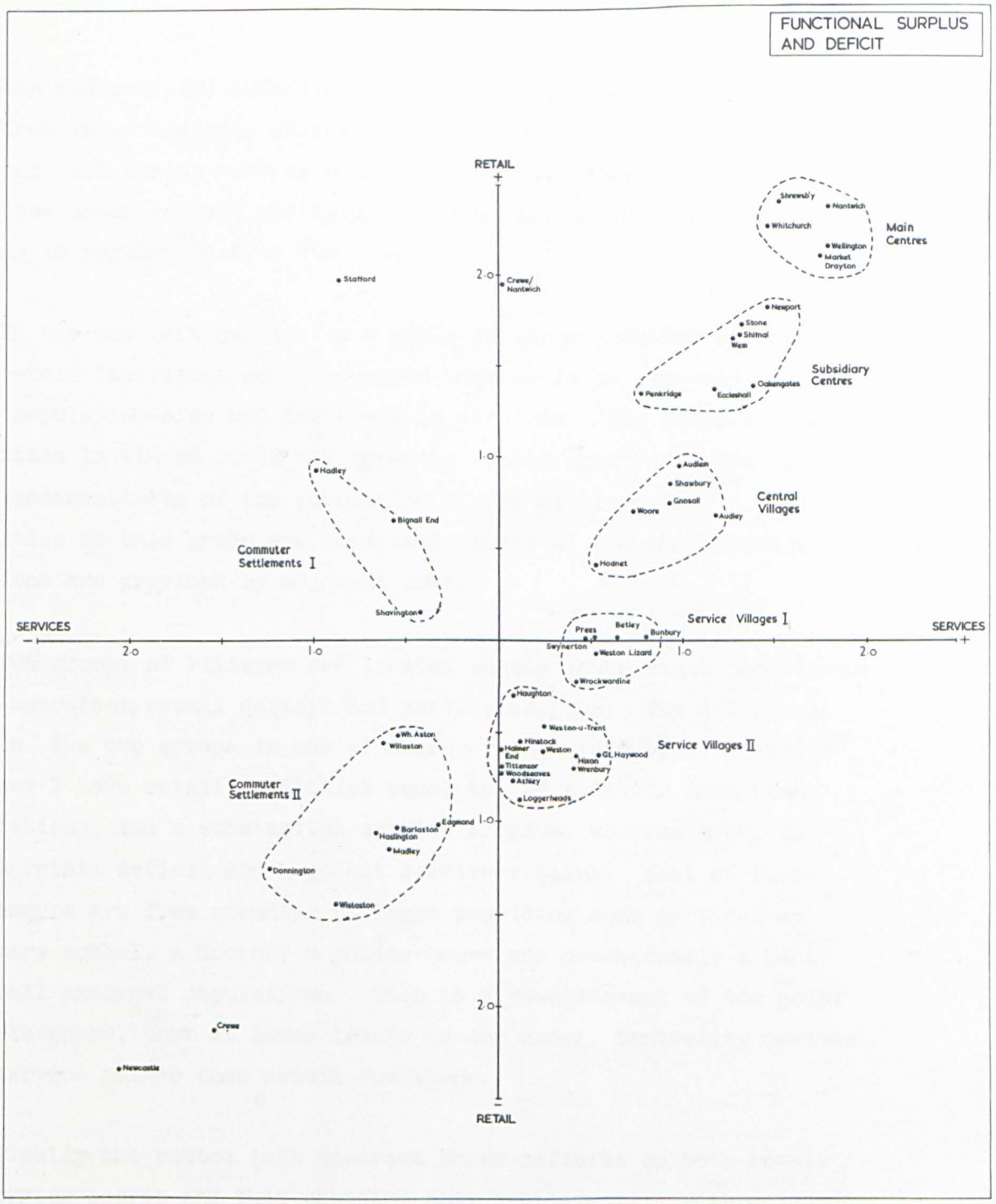

Figure 4.3 Functional surplus and deficit

(1) Main centres, (2) Subsidiary centres and (3) Central Villages. The first group includes Shrewsbury, Nantwich, Whitchurch and Market Drayton; all strong centres with well defined trade areas. Group 2 comprises urban centres and large villages and group 3 contains villages ranging in population from 600 - 2,500.

In the top left quarter is a group of large suburban settlements with retail facilities more elaborate than would be expected from their population size but deficient in services. The surplus of retail facilities is almost certainly apparent rather than real, and is due to an underestimate of the population of the settlements.(1) Service facilities in this group are invariably skeletal and the relevant functions are provided by adjacent towns.

Two groups of villages are located in the lower right hand sector which represents retail deficit and service surplus. The difference between the two groups is one of degree rather than type. Service villages I have retail facilities equal to, or slightly less than expectations, and a substantial service surplus, whereas group II have a retail deficit and a modest service surplus. Most of these settlements are free standing villages providing such services as a primary school, a doctor, a police-house and occasionally a bank for small external populations. This is a re-statement of the point made elsewhere, that at lower levels in the order, centrality derives from service rather than retail functions.

Finally the bottom left quadrant shows deficits on both retail and service scores and this contains many settlements. With only two exceptions these fall into a group which may conveniently be

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(1) The population of villages and suburban settlements for which no direct census data was available were estimated from their number of dwelling units listed in local authority rating and valuation lists.

termed 'commuter villages'. Their populations range from 1,000–8,000 and in all respects they are closely linked to nearby towns, which provide the required retail and service facilities, as well as employment opportunities.

Three important towns fail to accord with the anticipated pattern. Newcastle and Crewe are shown to have deficits in both retailing and services, and Stafford, a county town, has a substantial service deficit. The reasons for these apparent anomalies are both actual and methodological. Newcastle, although an important central place providing a wide range of goods and services for much of rural north-west Staffordshire, owes its inferior status on Figure 4.3 to its position within the trade shadow of other centres. An intricate nesting arrangement of service areas exists whereby Newcastle caters for a substantial external population, but many of the townspeople obtain goods and services from nearby centres in the Potteries, and especially Hanley.

In a similar way Crewe loses trade to Chester and also to its near neighbour Nantwich. Since the retail score is based upon the number of establishments, rather than turnover, Nantwich with a large number of relatively small shops and its specialisation at the higher quality end of the retail trade, gains over Crewe. In addition Crewe's socio-economic structure is biased towards the lower end of the income scale relative to other centres in the area, so almost certainly the demand for goods and services is lower here than elsewhere. (1) If Crewe and Nantwich are considered as complementary centres, their combined scores show a small service surplus and a large retail surplus.

(1) 1966 Census Table 14. Economically active and retired males 15 years plus

Occupational Class	Crewe M.B.	Oakengates U.D.	Shrewsbury M.B.	Wellington U.D.	Newcastle M.B.	Stafford M.B.
% professional/Managerial classes, 1, 2,3,4, 13.	5.3	6.6	16.3	15.3	14.4	16.0
% unskilled Class II	10.6	7.1	7.1	8.1	9.6	7.7

The apparently anomalous position of Stafford is an indication of unintentional bias in the selection of services for consideration. The services chosen favour the market towns and major villages but deflate the real scores of the larger centres. This could be rectified by the inclusion of higher order services unique to the large centres, e.g. lawcourts, medical consultants, technical schools. The groups of settlements identified in Figure 4.3 have been mapped in Figure 4.4 It is difficult to say that this represents a truly hierarchical pattern of central places, for several towns which do not form part of a group have been omitted — e.g. Crewe, Newcastle and Stafford. The reasons for these anomalies have already been discussed. The largest surplus of both retail and service functions are shown by the free standing market towns, e.g. Wellington, Whitchurch, Market Drayton and Nantwich, and these together with Shrewsbury form the top tier of the hierarchy of functional surpluses. Suburban settlements cluster around Crewe/ Nantwich, and to a lesser extent around Wellington/Oakengates, and there is a relative paucity of centres in the west of the area.

With the exception of the positions of the three towns of Crewe, Newcastle and Stafford there is some comparison between the ranking of settlements by their functional surplus/deficit, and that derived from their total functional provision, but there is little agreement between the groups identified by each method. This is understandable on the basis that a functional surplus/deficit approach groups settlements according to type, with size (measured both in terms of population and functions) as a secondary element. Grouping the total functional score places more emphasis upon actual functional size.

A refinement to the above analysis is available in certain cases in that details of the retail turnover for different categories of goods

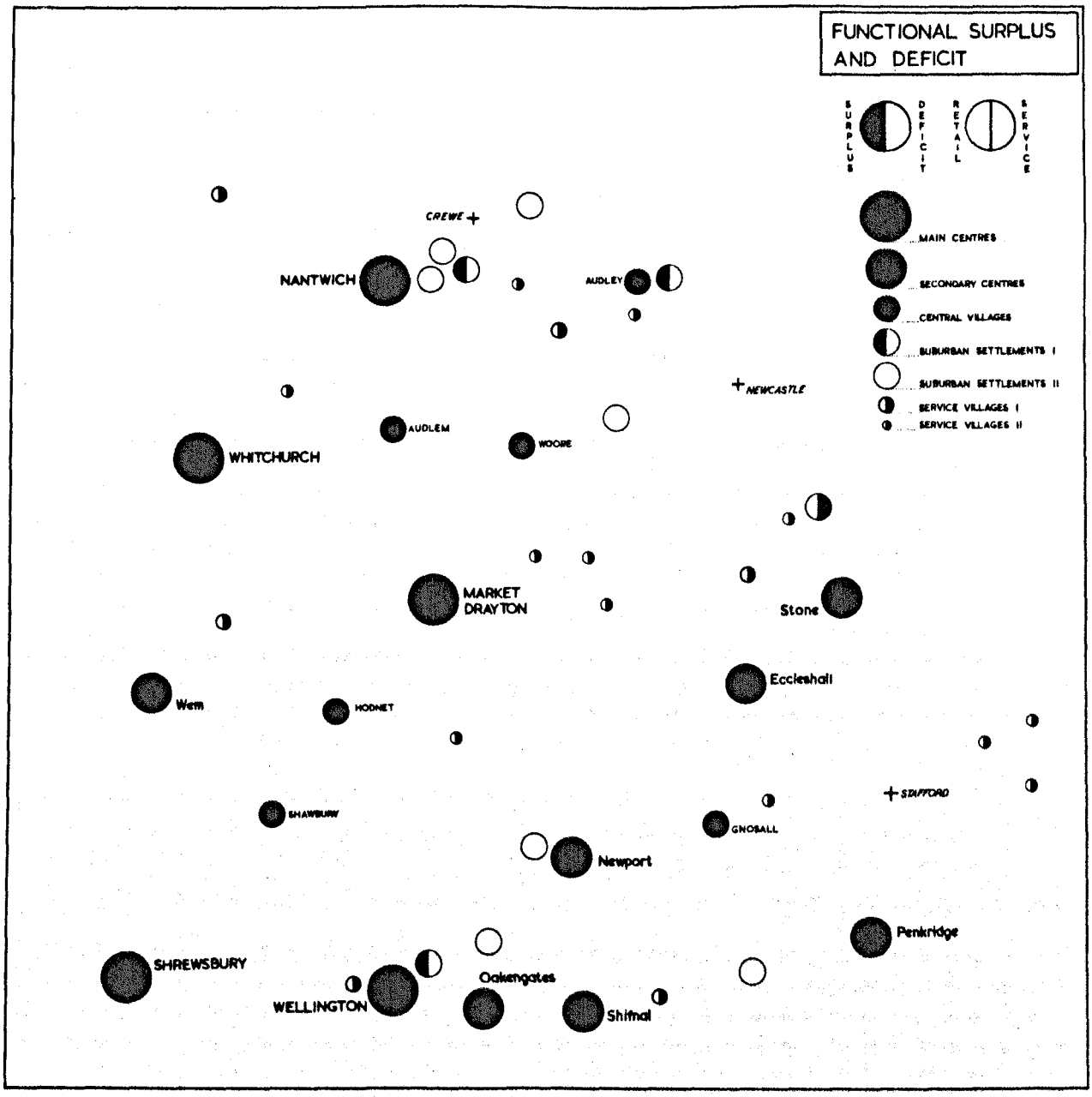

Figure 4.4 The distribution of settlements showing functional surplus and deficit

is available from the 1961 Census of Distribution.(1) Knowing the average family expenditure on different goods it is possible to calculate how many households are being provided with each kind of good by each town.(2) The turnover for durable goods was divided by the average annual family expenditure on these goods, and the number of families supplied by each centre was thereby calculated. This figure was converted into the number of persons, and where a surplus over the town's resident population resulted it indicated that an external population was being served.

Table 4.3 records the surplus or deficit shopping populations being provided with durable goods in the study area. Four towns, Crewe, Shrewsbury, Wellington and Stafford show large surplus populations, and most of the small country towns are also shown to have an external trade area for durable goods. Again Newcastle is anomalous. This is undoubtedly an important central place and market town for much of North Staffordshire, and yet it records a deficit population of 902. The reasons for this apparent contradiction have already been discussed and point further to the limitations of regarding centrality purely in terms of central equipment possessed by each town.

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(1) Retail turnover figures are available only for centres classified as urban districts, and then only for entire local authority areas, except in the case of towns over 50,000 population where a central area is defined.

(2) Household expenditure was taken from the Regional Tables (table 3) of the Family Expenditure Survey 1962. This figure was weighted according to the social structure of each town as suggested by Kantorowich in 'Regional Shopping Centres in N.W. England' University of Manchester 1964. A household was taken to be 3.05 persons. Retail turnover data comes from Table 3 of the 1961 Census of Distribution and from information supplied by the Board of Trade. Durable goods are here defined as all retail goods less food, confectionery and tobacco.

TABLE 4.3.

External populations served by towns, calculated from Retail Turnover and Family Expenditure Data

Town	Surplus/Deficit population for durable goods
Shrewsbury	53,670
Crewe	33,053
Wellington	16,000
Stafford	12,937
Newport	6,370
Whitchurch	5,410
Market Drayton	3,975
Nantwich	2,890
Wem	16
Newcastle	— 902
Stone	—1,317
Oakengates	—3,208

In sharp contrast to its position of retail deficit in Figure 4.3 Crewe is here shown to have a substantial surplus population. This is due to the difference in assessing retail status as the number of establishments or as total turnover. Crewe has a relatively small number of central area shops but they are mostly large efficient units with high individual turnovers.

Non-retail Measures of Centrality.

The total centrality of a settlement is the result of a complex amalgam of functions. The retail, service and social functions are examined at length in this thesis, but at this stage it is proposed briefly to introduce two more components of the overall pattern. These two components are the market function, and the employment function; the justification for their inclusion is partly that they indicate the expansive nature of the concept of centrality, but also because by their unmanageable and inconclusive nature they help to explain why so much emphasis is given elsewhere, and in this work, to retail and service functions.

The existence of a livestock or produce market in a settlement was long the primary evidence of town/country interaction, and in a rural area such as this it remains an undeniable expression that a town or village is acting as a central place. The market function is not easy to quantify since there is much variation in size, frequency of occurrence and efficiency, but it is evident that a market contributes to a town's centrality, not only in its own right, but also in the form of the increased business which it generates for goods and services.

During this century there has been extensive rationalisation of the market structure, and as with retailing functions, it is the smaller centres which have been disadvantaged. Improvements in transport in particular have brought advantages to the larger, better organised

markets, although this in turn has meant that communication centres such as Crewe have developed as regional markets, thus overwhelming their original local centrality.

Figure 4.5 compares market patterns in 1927 and 1967. The most obvious change in the forty years has been the reduction in the number of market locations. In 1927 there were 21 livestock markets in the area, but by 1967 this had been reduced to 10 centres, the years between 1938 and 1946 witnessing the most severe contraction. The extinction of produce markets has been less marked. Only two, those at Audlem and Oakengates closed within the time span, and with the exception of Penkridge this is now an entirely urban function.

The periodicity of markets suggests that in some well-developed towns one can anticipate three hinterlands: -

(1) the market day hinterland embracing rural shoppers.
(2) the restricted weekday hinterland.
(3) the Saturday hinterland embracing particularly shoppers from smaller towns, suburban villages etc.

Centrality and Place of Work.

In many respects journey to work patterns are an integral part of central place study, although they are rarely treated as such: certainly they give expression to a force, or forces, drawing people from a contributary areas to a central location where the need to earn can be fulfilled. A pattern of central places drawn up on the basis of workplace-flow would bear some semblance to one based upon retail or service provision, but there

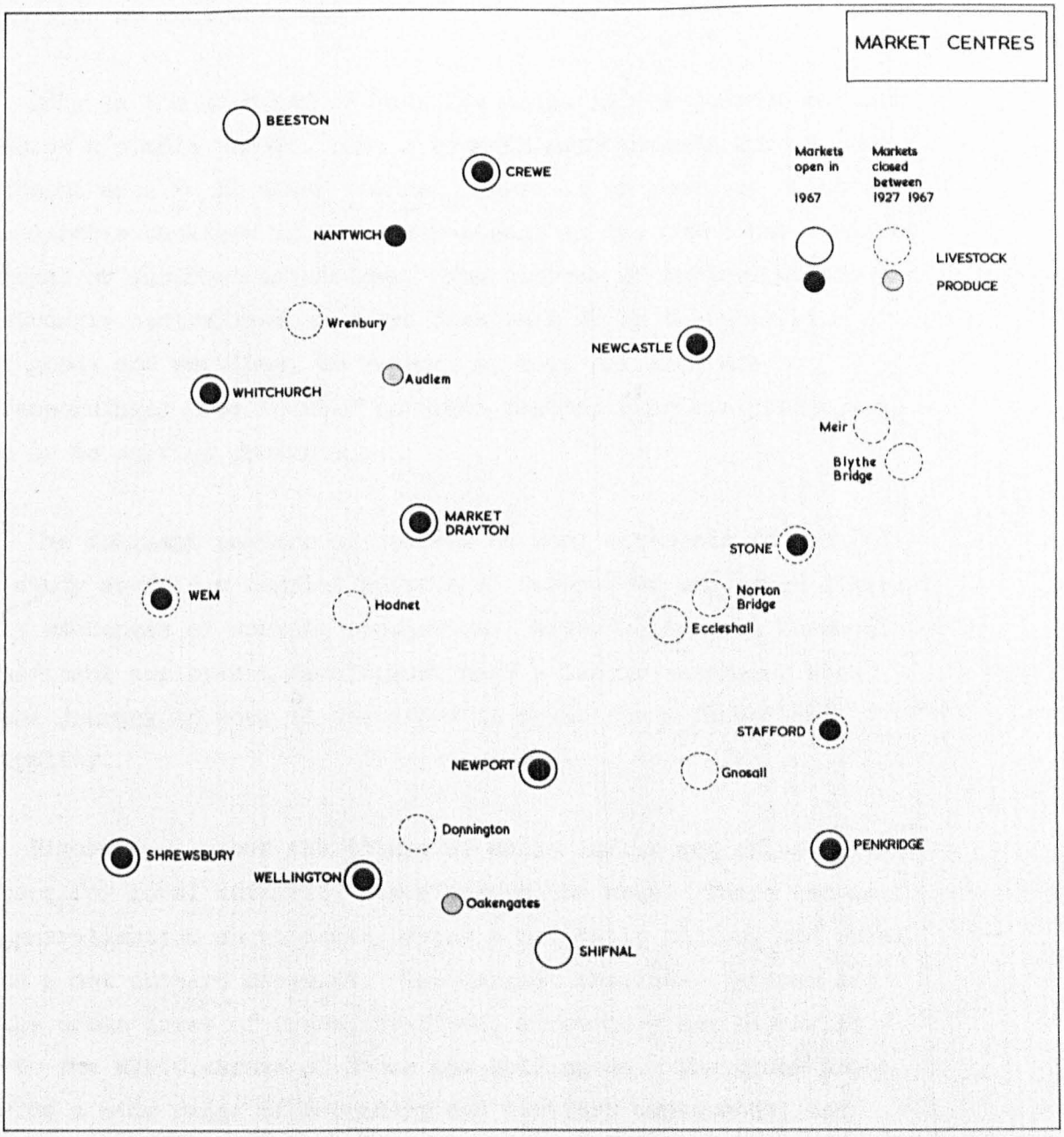

Figure 4.5 The distribution of market centres in 1927 and 1967

would also be many differences.

Only in the simplest of possible cases is the journey to work movement a simple radial one, overwhelmingly inwards from a labour catchment area to an urban centre. There is in practice often a considerable backflow of workers resident in the towns but employed in rural or suburban situations. The sources of employment are not so strongly centralised in urban locations as is the provision of most goods and services, so journey to work patterns are correspondingly less focused on urban centres than are journeys to shop or to service provision.

The dominant pattern of journey to work movements in much of the study area is a complex pattern of inter-town and inter-district daily exchanges of working population. Nevertheless all towns of significant employment development have a labour catchment area, so the journey to work is therefore in principle a factor in centrality.

Figure 4.6 shows the totals of daily influx and eflux of workers for local authority districts in the area. There can be no generalisation about towns having a net daily inflow, and rural areas a net outward movement. The largest absolute inflows are to the urban areas of Crewe, Stafford, Shrewsbury and Newcastle, and to the R.D.C. areas of Stone and Wellington. The urban areas provide a wide range of secondary and tertiary employment, and the rural districts are favoured by the location of four large employers, viz. the Royal Ordnance Depot and Joseph Sankey's engineering works in Wellington R.D.C., and the Wedgwood factory and the C.E.G.B. power station in Stone R.D.C.

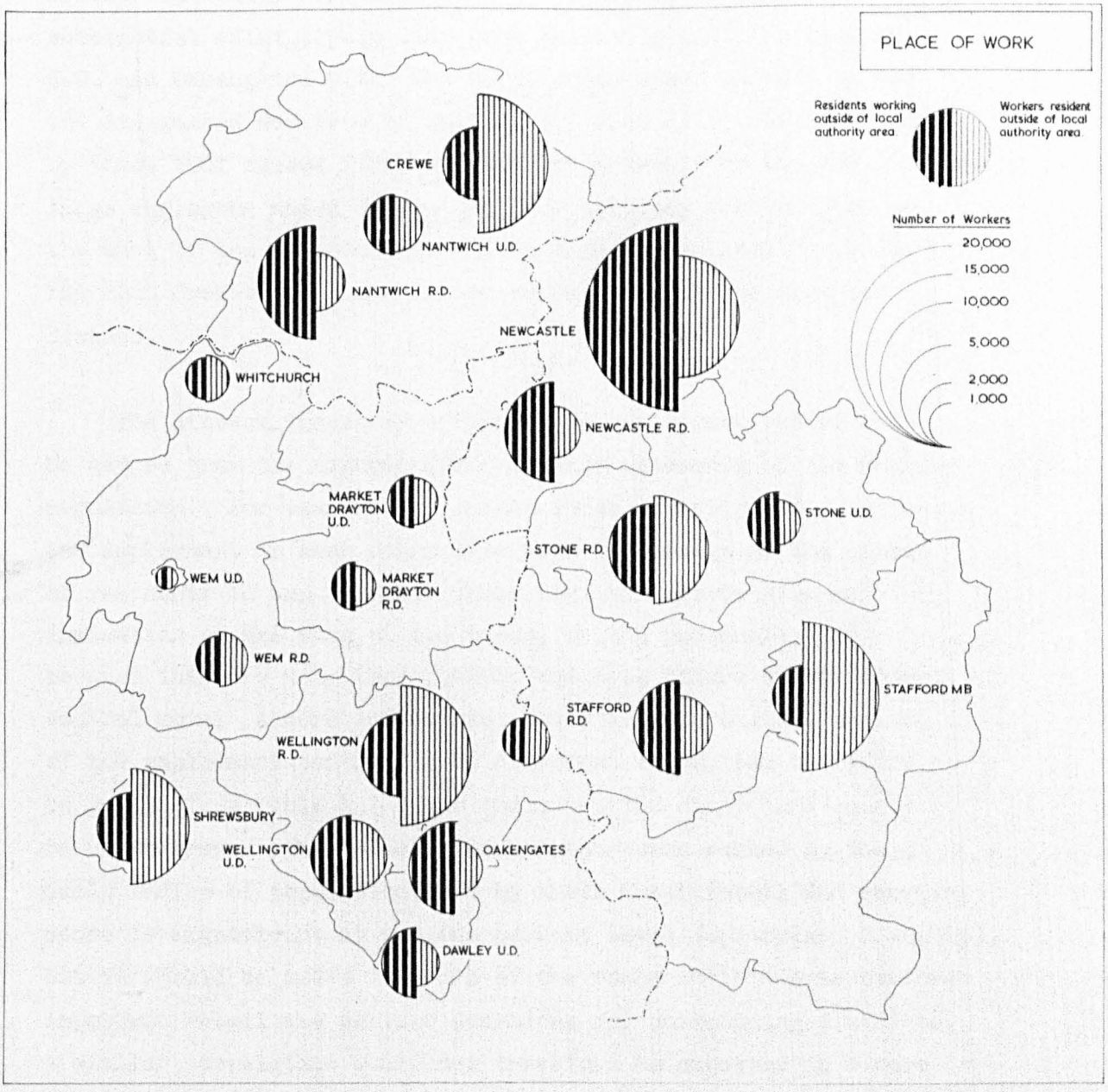

Figure 4.6 Place of work, administrative areas

The largest gross daily outmovements are mostly from rural areas, especially Nantwich, Newcastle, Stone and Stafford, but substantial eflux occurs also from Newcastle M.B., Wellington U.D. and Oakengates U.D. The three urban areas in what is now the designated New Town of Telford all show daily outmigrations by these 1961 census figures; this is a result of the two large employers noted above, and of a colliery located just to the east of the urban areas. It is within this small area that the most dramatic changes can be anticipated in the next few decades.

The attractiveness of a town as an employment centre can be gauged from the figures for the daily movements of the working population. For example the simple index in table 4.4 indicates the employment in each urban area as a percentage of the number of residents in employment. These figures however give no indication of the size of the towns, or the movements, and because they are net, they obscure the true nature of the inward, central move, A more indicative, but still approximate measure of the employment centrality of different towns, can therefore be gained from Table 4.5 which indicates the daily inmovements to urban areas. The correlation between towns ranked by their daily inflow of population, and by their total retail and service score is significant at the one percent level (Spearmans $R = 0.819$), but it should be noted that all of the towns in this area perform important retail and service functions for surrounding districts; a similar correlation would not therefore be expected in a more industrial area.

This chapter has illustrated the complex nature, and some of the many facets of the concept of centrality. Some of the approaches have shown themselves to be unworthy of extension per se,

Table 4.4.

Town	Index of Employment related to No. of residents
Stafford	142.2
Crewe	129.6
Shrewsbury	118.5
Newport	102.6
Whitchurch	102.0
Nantwich	97.0
Wem	96.5
Market Drayton	92.8
Wellington	91.5
Stone	79.3
Newcastle	73.6
Oakengates	55.9

Table 4.5

Town	Daily influx of working population	Rank	Rank by Retail and Score Service
Stafford	10,940	1	3
Crewe	9,270	2	4
Newcastle	7,950	3	2
Shrewsbury	6,280	4	1
Wellington	2,640	5	6
Nantwich	1,840	6	5
Oakengates	1,440	7	9
Stone	940	8	10
Newport	900	9	11
Market Drayton	830	10	8
Whitchurch	820	11	7
Wem	250	12	12

they are unsatisfactory measures of urban centrality in themselves but they do go some way towards an integrated presentation of the concept.

Of the alternative approaches outlined here, only the discussion on functional surplus/deficit would seem of positive value in the resolution of central place relationships. By relating the functional equipment of settlements to their resident population this technique indicates the magnitude and direction of the functional surplus or deficit, and enables the comparative positions of different centres to be plotted, and the subsequent isolation of groups of settlements with similar functional characteristics.

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Chapter 5 -
Central Places at Lower Levels

Few central place studies are explicit about lower order settlements.[1] Of necessity much of the foregoing analysis has been confined to large, functionally complex centres of middle or high rank, but it is felt that a substantial examination of the problems of central place study at lower levels is relevant in a survey of an area that contains so many settlements of small size and less than urban status.

The definition of a village and its distinction from a town is perhaps an exercise in semantics, for the name is applied to a wide variety of settlement types. The past two decades have seen immense changes in the structure of villages all over Britain, and undoubtedly the main agents of change have been firstly the development of rural bus services and subsequently the spread of private car ownership. The increase in personal mobility brought about particularly by the car has changed many villages from self-contained communities into dormitory settlelemts for nearby towns. The prestige of living in these settlements has ensured the continuation of the apellation "village", but many, like Wistaston and Haslington are urban or suburban outliers with only a pseudo-village structure.

The small settlements considered here are defined as those villages, numbering 157 in all, which fall below the fundamental break in Table 6.3 ; in general these are 'villages' not only in terms of rank-order, but also in population size.

Statistically the correlation between resident populations

of these settlements, and their functional complexity (measured as their total score for retail, service and social facilities) appears to be relatively high. ($r = 0.425$, signicant at the 0.1 percent confidence level).

A regression analysis of village centrality scores upon population size however shows that this high degree of correlation is in part deceptive. (see Figure 5.1.) Although the correlation is high, population alone is shown to be a poor basis upon which to estimate a village's centrality score. The main restriction is that the data is highly skewed, that is, it is disproportionately concentrated among villages with less than 300 people. In the light of this non-normal distribution the graph must be interpreted cautiously, and conclusions drawn from which it will relate only to the universe immediately at hand.[2] With these limitations in mind the regression and correlation exercises are considered to be a worthwhile analytical tool for our purposes.[3]

The unsuitability of using population as a basis for predicting a village's score, in spite of the significant correlation between the two factors is shown in Figure 5.1 by the large size of the standard error.(i) In numerical terms the standard error $Sa = 3.16$; thus for a village of population say 200, the score can only be estimated from the regression line as 4.05 ± 6.32. Thus the extremes within which the score might fall range from + 10.37 to 0.(ii)

One of the main merits of Figure 5.1 however, and the one which justifies its inclusion, is that it does identify those villages whose relationship between score and population diverges by more

(i) The calculation of the standard error Sa does not involve the assumption that the data is distributed normally.

(ii) Where there is a 95 percent probability that $a = 4.05 \pm 2\ Sa$. The score cannot be < 0

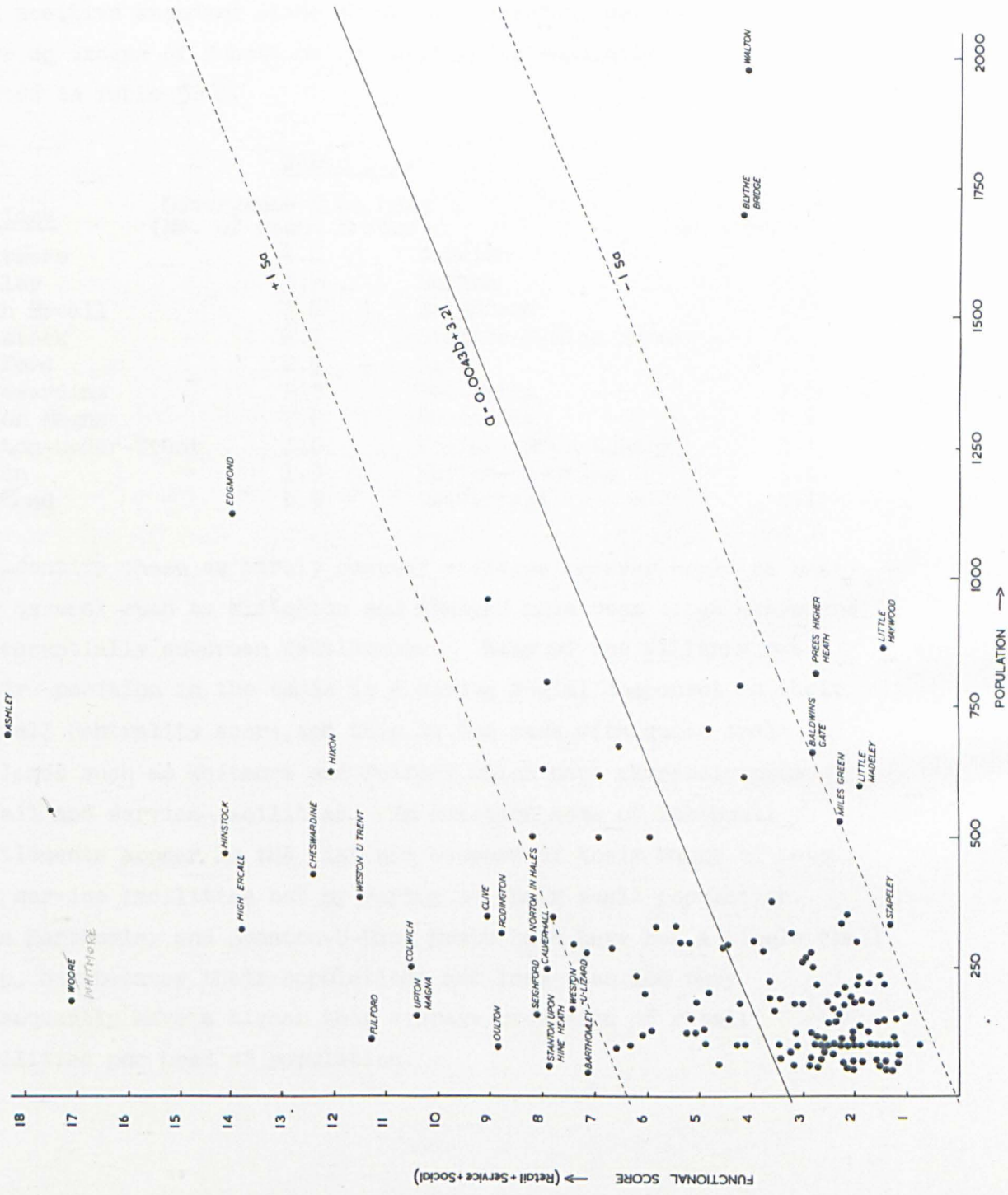

Figure 5.1 The relation between village functional scores (retail + service + social) and population

than one standard error (positive or negative) from the mean. The category of settlements which diverge from the mean by more than one positive standard error which may therefore be considered to have an excess of functions in relation to population size is listed in Table 5.1.

TABLE 5.1.

Village	Divergence from Mean (No. of Stand. Errors)		Divergence from Mean (No. of Stand. Errors).
Whitmore	4.0	Colwich	1.9
Ashley	3.7	Oulton	1.6
High Ercall	2.8	Seighford	1.3
Hinstock	2.7	Stanton-U-Hine Heath	1.3
Fulford	2.4	Clive	1.3
Cheswardine	2.3	Rodington	1.3
Upton Magna	2.0	Barthomley	1.2
Weston-under-Trent	2.0	Weston-under-Lizard	1.1
Hixon	1.9	Norton-in-Hales	1.1
Edgmond	1.9	Calverhall	1.1

To identify these as truly central villages however would be hasty, for several such as Wistaston and Edgmond have been cited elsewhere as essentially suburban settlements. Many of the villages owe their position in the table to a strong social component in their overall centrality score, and this is the case with quite small villages such as Whitmore and Fulford which have extremely poor retail and service facilities. In addition some of the small settlements appear in the list not because of their range of retail and service facilities but by virtue of their small population. Thus Barthomley and Stanton-U-Hine Heath both have but a single small shop, but because their populations are less than 100 they consequently have a higher than average provision of retail facilities per head of population.

At the other extreme is a small group of settlements which have a score/population relationship greater than one negative standard error away from the mean. These are shown in Table 5.2

TABLE 5.2.

Village	Divergence from mean (No. of Stand. Errors)	Village	Divergence from mean (No. of Stand. Errors).
Miles Green	1.0 (S)	Little Madeley	1.2 (SC)
Baldwins Gate	1.1 (S)	Little Haywood	1.7 (SC)
Stapeley	1.1 (S)	Blythe Bridge	1.8 (S)
Prees Higher Heath	1.2 (S)	Walton	2.3 (S)

Without exception these low scoring settlements may be explained by two reasons. The first and that which applies to most of the group is that the villages are suburban or commuter settlements of recent growth (S), often with relatively high income populations and consequently high car-ownership ratios, which look to nearby towns for even the lowest order goods and services. The remainder may be accounted for by their position of complementary (C) with another nearby or adjoining village which provides the bulk of goods and services for both settlements. Whether it is valid to claim high centrality for the villages in Table 5.1 depends upon the definition of the word "centrality" and the structure of the quantitative measures that have been used to describe it. What the social component measures in the centrality score, is the scale of social activity and the degree of social organisation within a settlement. This may appear to be an insecure basis for claiming any real distinction for a village, but it has been shown elsewhere that there is a strong correlation between the rankings of villages on a social basis and ranking by retail and service provision (ref. Chapter 3 p.71) and there is a strong case for suggesting that social vitality presents another and important dimension of the centrality of small settlements.

To remove any bias which may have been caused by the use of this social component, the village scores for retail and service functions have been plotted against population in Figure 5.2. Again the scatter of data and the size of the standard error show that in spite of a high correlation coefficient of $r = +0.62$ (significant at 0.1 percent level) it is inadvisable to expect a close relationship between individual village scores and their population sizes. For a village of population 200 it is only possible to state with a 95 percent probability that the score will be 1.85 ± 1.98, i.e. the range is more than twice as large as the mean predicted value.

Again the only value of this correlation and regression analysis lies with its identification of extreme anomalies and as with the first case it is possible to isolate settlements where the score/population ratio varies extensively from the mean. Those villages with excessively large scores for their population are listed in Table 5.3.

TABLE 5.3.

Village	Divergence from Mean (No. of Stand. Errors)	Village	Divergence from Mean (No. of Stand. Errors).
Hixon	3.9	Weston-under-Trent	1.7
Halmer End	3.4	Sandon	1.6
Weston-under-Lizard	2.6	Oulton	1.4
Wrenbury	2.3	Bromstead Heath	1.4
Haughton	2.2.	Milford	1.4
Swynnerton	2.1	Whitmore	1.3
Ashley	1.9	Croxton	1.3
Wrockwardine	1.9	Cotes Heath	1.3
Hinstock	1.9	High Ercall	1.2
Loggerheads	1.8	Tittensor	1.1
Weston (Crewe)	1.8	Woodseaves	1.1
Worleston	1.8	Alpraham	1.1
		Church Eaton	1.1

Only one third of these villages also appear in Table 5.1, but the table above contains fewer suburban/commuter settlements than Table 5.1.

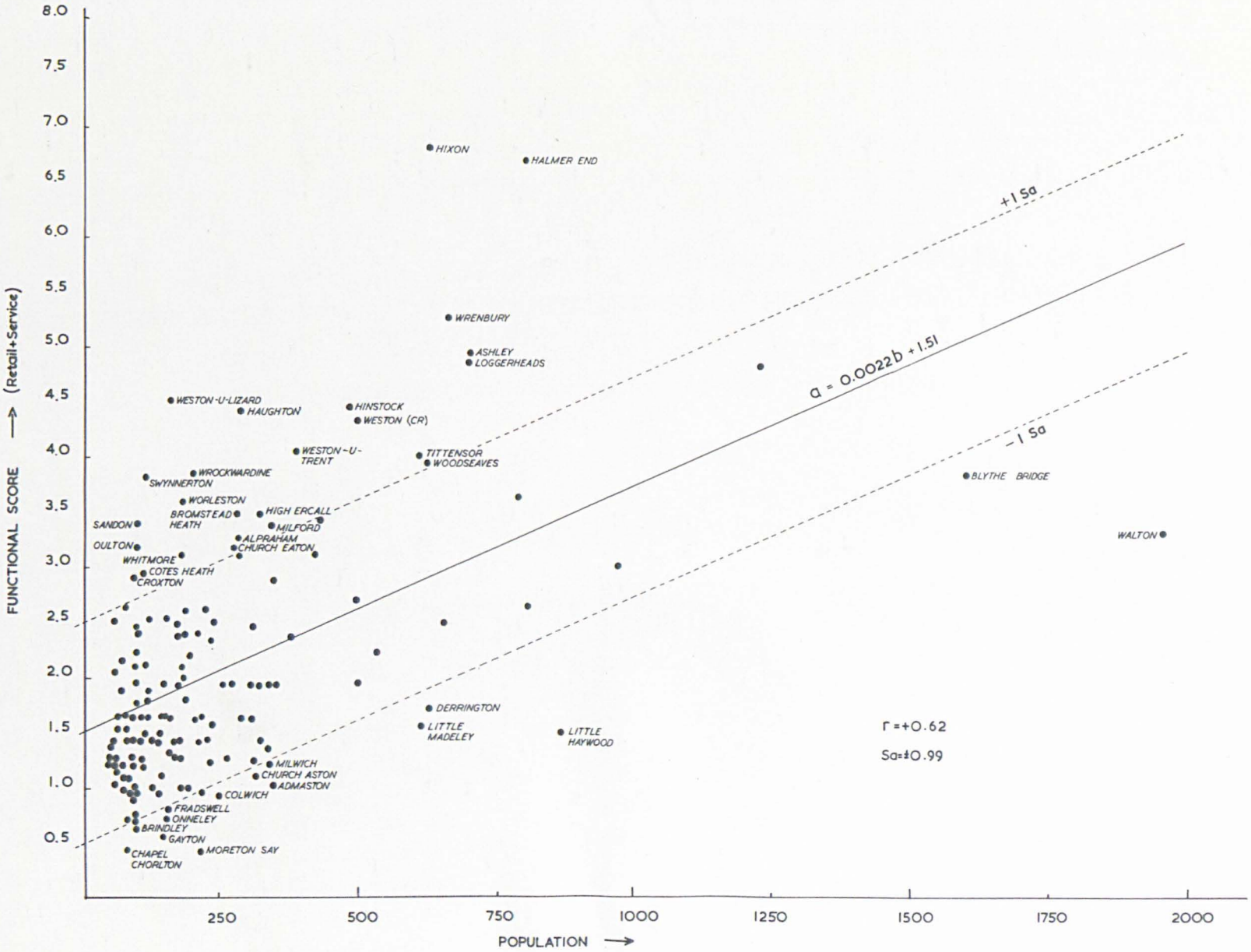

Figure 5.2 The relation between village functional scores (retail + service) and population

Again we should be cautious in interpeting the settlements in Table 5.3 as true central villages. One particular constraint lies in the size of shops, which in villages vary widely. Since the excesses noted from the graph depend upon the number of shops found in each village, we must also note that a settlement with two, or even three small and old-fashioned general stores may have a smaller retail turnover, and a more restricted choice of goods than a village with one large modern store. This cautionary note also applies to the villages with scores greater than one negative standard error away from the mean shown in Table 5.4.

TABLE 5.4.

Village	Divergence from the Mean (No. of Stand. Errors).	Village	Divergence from Mean (No. of Stand. Errors).
Milwich	1.1	Blythe Bridge	1.2
Brindley	1.1	Gayton	1.3
Fradwell	1.1	Chapel Chorlton	1.3
Colwich	1.1	Little Madeley	1.3
Church Aston	1.2	Moreton Gay	1.5
Derrington	1.2	Little Haywood	1.9
Onneley	1.2	Walton	2.7
Admaston	1.2		

A comparison of Table 5.1 and 5.3 suggests that commuter villages rely more heavily on the social component in their centrality sores for the rank assigned to them, than do more rural villages. In a real sense this is true; the only power to attract external populations to many commuter villages is their often considerable social vitality, for they offer virtually no retail or service provision.

The functional equipment of villages

It has already been suggested that most villages have undergone considerable functional changes in the past few decades. Many villages have declined in importance but others have adjusted to new roles and have found continuing prosperity.

In the field of employment very few villages are now self-contained, and many locally based jobs and crafts have vanished. In some cases the craft has vanished almost entirely from contemporary life (e.g. the wheelwright, saddler, thatcher, etc.) occasionally it has evolved into a different form with different locational requirements, for example, the smithy and saddler being replaced by the highway orientated garage/ filling station, but more often the village functions have been usurped by nearby towns.

Apart from the residential role of villages there are three groups of functions which a small settlement may fulfill, and which contribute to its centrality. These can be given the general titles of retail, service and social functions.

Retailing in villages.

The types of shops characteristically found in villages differ appreciably from those in urban centres. The main difference is the heavy bias towards food shops and outlets for other perishable goods in the village, but table 5.5 shows this in more detail. (A full list is given in Appendix B.)

Table 5.5.

	Proportion of food shops	Proportion of clothing shops	Proportion of household hardware shops	Proportion of other shops
Urban Centres	20.5	25.9	22.0	31.6
Non-urban centres	66.7	9.0	10.7	13.6
Central villages (i)	47.3	14.4	18.0	20.3
Grade A villages	55.3	11.9	14.3	18.5
Grade B villages	86.7	3.6	1.2	8.5
Grade C villages	100.0	0	0	0
Grade D villages	100.0	0	0	0

(i) derived from table 6.3.

In all of the non-urban centres food stores comprise exactly two-thirds of all retail establishments; this figure is smaller for the central villages and Grade A villages, but increases to 100 percent for Grades C and D. Furthermore, the larger villages have both a greater variety and a wider specialisation in their range, with butchers and greengrocers frequently occurring, in contrast to the lower grades where the sole retail representative is a general store/grocer.

Clothing shops are but poorly represented in the villages and overall they form less than one-tenth of the total number of shops in non-urban centres. In those which do occur, womens' and childrens' clothes are most commonly stocked, although many establishments provide a limited range of general and working clothes for men and women. Household hardware stores are commonly found in the larger villages and although the ironmongers and electrical shops are most typical of this category there are many which sell a variety of household needs and

basic materials for the home handyman. The group of "other" retail establishments at village level comprises mostly newsagents/tobacconists/confectioners, although it also includes chemists and antique shops.

The above suggests that the self supporting nature of villages has given way to increasing dominance by urban centres and we can broadly agree with Isard and Whitney [4] that the higher ranking towns and cities tend to usurp trade from the small centres within their sphere of influence but that perishable goods of "convenience" type, especially food, suffer least(i) in this process.

The appearance and age of village shops varies greatly. Units are generally small and are frequently converted dwelling houses. Rarely small groups of modern purpose-built units may be seen (e.g. Haughton or Shavington) and although chain stores or multiples do not occur in villages, some of the more progressive stores are associated with bulk buying organisations.

Service facilities in the villages

Since the range of retail facilities in villages is frequently very restricted, these settlements gain much of their functional status from their provision of services. Typically the establishments from which services are offered tend to be small and to occupy non-central premises within the settlements. This, together with the lack of census or any other systemmatic data makes the measurement and analysis of services less easy than that for the retail sector.

Although the services chosen for examination were designed partly to bring the smaller settlements into the functional spectrum, they

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(i) or last.

were found to be strongly concentrated in the urban areas. Table 5.6. illustrates this concentration among the professional and financial services.

Table. 5.6.

	No. of establishments in urban areas (%)	No. of establishments in non-urban areas (%)
Post office	6.0	94.0
Bank	73.6	26.4
Doctor	67.7	32.3
Dentist	97.4	2.6
Optician	96.2	3.8
Solicitor	95.2	4.8
Accountant	100.0	0
Auctioneer	90.3	9.7
Vetinary Surgeon	93.7	6.3

It was impossible to follow Berry and Garrison [4a.] to calculate a meaningful threshold of population size which a settlement had to reach before a given function appeared, for many wide variations were found to exist. For example, a single doctor was found in settlements as disparate in size as Knighton (pop. = 120) and Shavington (pop.=3,300). On the other hand three doctors were found in Hodnet (pop. = 584), and none at all in Bignall End (pop. = 2,060). In short the relationship of "service" provision to population size in villages is non- linear, and seems indeed to be non-systematic.

The distribution of nine professional/financial services named above is summarised in Table 5.7.

Table 5.7

	% of villages (i) possessing named service
Post Office	85.4
Bank	9.9
Doctor	19.2
Dentist	0.5
Optician	1.0
Solicitor	3.1
Accountant	0
Auctioneer	3.0
Vetinary Surgeon	3.0

(i) non-urban centres

Personal service as a component of centrality are also biased towards an urban location and it is difficult to identify any of these which are important at village level. Of the four chosen, travel agents are exclusively urban-based, dry cleaners and turf accountants were each represented in only 4 percent of the villages and although ladies hairdressers are rather more widespread, being found in 17 percent of villages, their presence tends to reflect individual enterprise more than village size. Table 5.8 provides a summary of the distribution.

Table 5.8

	% of establishments in urban areas	% of establishments in non-urban areas
Ladies hairdresser	69.7	30.3
Dry cleaners	85.2	14.8
turf accountant	72.0	28.0
travel agent	100.0	0

Retail, professional and other service provision in the villages reveals little tendency towards aggregation. Although an order of central villages is distinguished (see chapter 6), service and retail provision in the countryside is often dispersed. Thus one village will have a butcher's shop, another a bank and another

a doctor. A group of adjacent villages may, between them, have a fairly full range of services, but dispersed not focused. A principle of complementarity at lower levels in the hierarchy contrasts with the competition at higher levels.

Since rural dwellings are rated in much the same as urban houses, the rating authorities have an obligation to provide a comparable standard of services in both areas. For this reason the local authority services (here called county services for convenience) contribute much to the centrality of rural settlements. Like most other facets of the overall service pattern, the provision of county services has been greatly affected by improved transport facilities. While this has brought about increased centralisation of the bases from which the services are provided, it has also allowed a more widespread distribution of the services themselves. For example the mobile library service has led to the closure of the smaller branches, but the service is now available to many more people. A similar rationalisation has affected the organisation of the police force.

The contribution which county services make to the centrality of villages is a decisive one; moreover through the County Development Plan the status of individual villages can be altered appreciably. "The pattern of settlement for the countryside should involve the concentration of development in a number of strategic points, and the creation or expansion at these points of villages that are of optimum size in the context of physical or other relevant circumstances".(5) In this way county authorities make use of, or create a hierarchy of villages each having a characteristic minimum service provision. Figure 5.3 illustrates the villages so designated where expansion of population and/or facilities is planned or in progress. Because of the rational basis upon which their provision is decided, county services are located not only as a direct correlate of population size, but also with due regard to an adequate spatial distribution

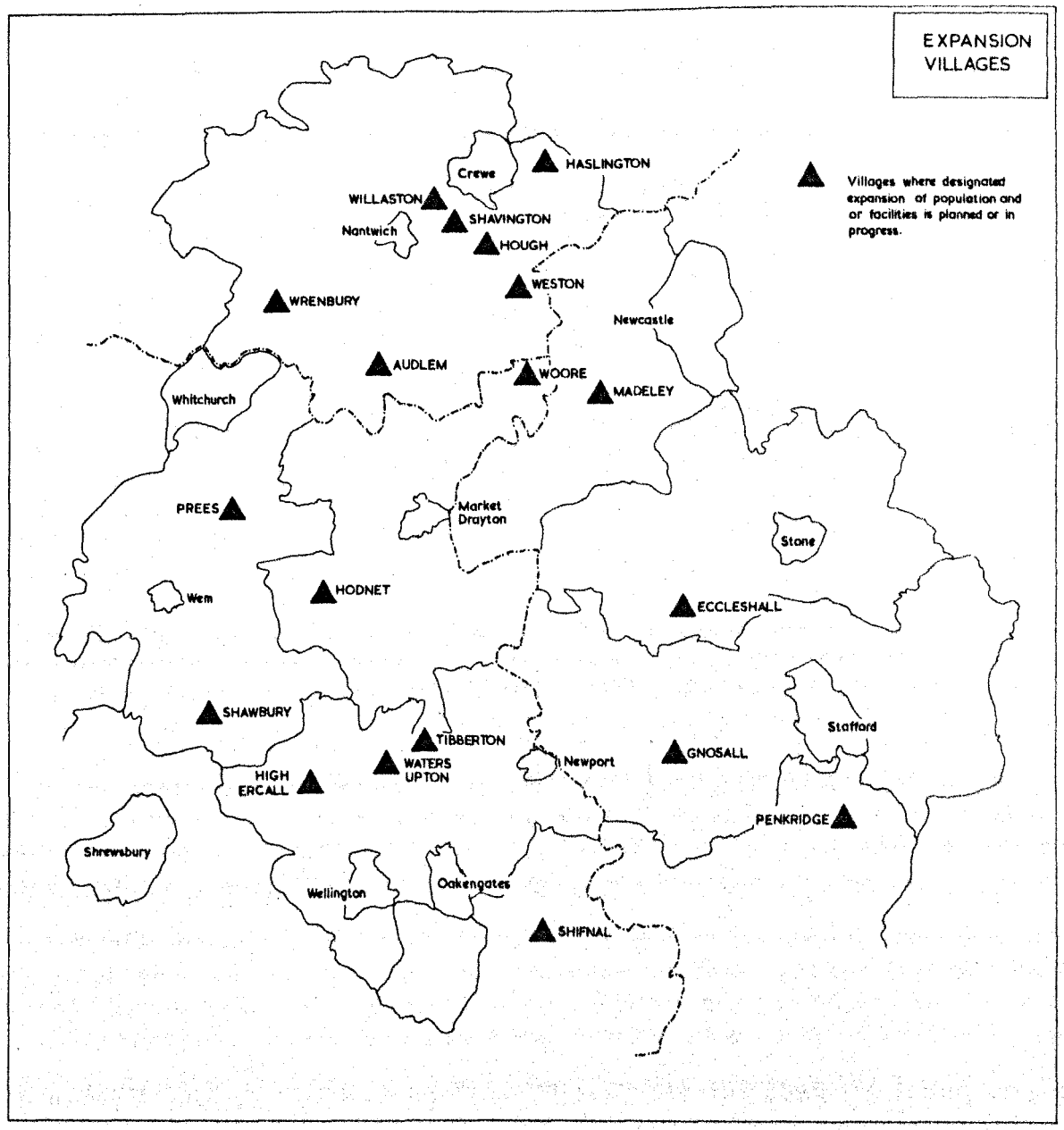

Figure 5.3 Villages for planned expansion

across the authority's area, in such a way that there is an attempt to minimise the distances which consumers will be caused to travel. In the long term this policy will doubtless guide the distribution of all retail and service facilities, but for the moment the effect of conscious planning is seen mostly clearly in the statutory services.

The distribution of the five representative county services in urban and non-urban areas is outlined in Tables 5.9 and 5.10.

Table 5.9

	% of service establishments in urban areas	% of service establishments in non-urban areas
Primary school	49.2	50.8
Secondary school	82.6	17.4
District nurse	58.9	41.1
Branch library	100.0	-
Mobile library	5.5	94.5
Police house	15.0	85.0
Police station	100.0	-

Table 5.10

	% of villages possessing named service
Primary school	59.0
Secondary school	6.7
District nurse	18.7
Branch library	0
Mobile library	79.8
Police house	31.6
Police station	0

The associations between the more commonly occurring village functions are summarised in Table 5.11. The only legitimate way to read this table is across the rows; thus of all settlements with a general store, 10.5 percent also possess other retail establishments, and 88.6 percent also have a post office etc.

Table 5.11

	General Store	Other Retail Establishments	Post Office	Doctor	Primary School	District Nurse	Library(Mobile)	Police
General Store	100	10.5	88.6	13.2	60.5	12.3	90.3	28.9
Other Retail Establishment	100	100	90.9	27.3	54.5	9.1	81.8	63.6
Post Office	79.1	7.8	100	10.9	61.3	12.4	89.1	28.7
Doctor	100	20.0	100	100	86.7	46.7	93.3	40.0
Primary School	75.8	6.6	86.8	10.9	100	14.3	83.5	24.2
District Nurse	83.3	5.6	88.9	11.1	72.2	100	88.9	55.6
Library (Mobile)	79.2	6.9	88.5	10.8	62.3	11.5	100	26.9
Police	84.6	17.9	94.8	15.4	56.4	25.6	89.7	100

The strongest tendency towards aggregation among these functions are exhibited by the figures underlined. These refer to general stores, post offices, primary schools and the mobile library, although it should be noted that these functions are in any case the most widely distributed. There is no suggestion that these relationships are directly causal, except in that the larger, more functionally complex villages have a higher chance of containing the rarer functions in addition to those which are more widespread. Thus the marginally higher order functions, such as doctors, and District Nurses associate strongly with the more common general stores and post office, but the reverse does not occur, nor would it be expected.

Social facilities were the third functional group investigated in the villages,and the survey of voluntary social provision was undertaken jointly by the author and the Rural Community Councils of Staffordshire, Shropshire and Cheshire. Questionnaires, designed to establish what bodies and social organisations met regularly in each village, were despatched to the secretaries of the village hall committees, or to other contacts nominated by the Rural Community Councils. Although initially a simple list, the organisations were subsequently grouped into (1) Church based (2) Women's (3) Young Peoples' (4) Sports (5) Miscellaneous. The response rate was 87.59 for villages in the overall study area.[6.]

It has been seen (chapter 3 p.71.) that there is a strong psoitive correlation between the ranking of villages by their social functions and that based on retail and service criteria. The classification and survey of social organisations and their occurrence in different villages presents many problems. For instance it is possible to state in general terms that the larger a village is, the more clubs, associations and other activities it is able to support. Table 5.12. endorses this, but population size is only one of many factors. Frequently the location

of the village in respect of large towns, the structure of the village population and individual enterprise are also important factors in determining the range of social facilities and activity available.

Table 5.12

Population of village	No. of clubs and organisations per village
0 - 100	4.3
100 - 300	6.8
300 - 700	10.4
700 - 1,500	14.1
1,500 plus	16.7

It is also interesting to note how the kinds of clubs vary according to the size of the villages in question. In brief this amounts to the fact that in small villages the majority of clubs tend to be specifically church or women's organisations, but that further up the scale these become relatively less important, and that sporting and miscellaneous clubs are more strongly represented. Surprisingly, perhaps, youth clubs form much the same proportion of the total in villages of all sizes. The table shows how the composition of clubs varies with village size. (The figures in each case have been rounded to the nearest whole percent).

Table 5.13

Size of village	% Church based	% Women's	% Young people's	% Sports	% Miscellaneous
0 - 100	36	17	13	10	24
100 - 300	28	15	17	14	25
300 - 700	26	13	15	11	34
700 - 1,500	23	10	17	15	35

This kind of division can also be seen in the organisation of social life when villages are grouped according to whether they are gaining or losing population. To some extent the two features are linked; in the study area it tends to be the larger parishes which are gaining population, for these are the commuter parishes close to the larger towns. A higher

proportion of sports and miscellaneous clubs in these parishes reflects their different population structure, and especially their higher proportion of younger people and those in higher socio-economic groups. The smaller percentage of church-based clubs can in part be explained by a higher membership for those clubs which do exist, but it also tends to suggest that the church has limited influence in these 'newer' areas.

Villages have been grouped according to the total number of clubs and organisations they possess (Table 5.14). It can be seen that the top group is comprised of large villages which have sufficient shops and other services to dominate their own small area of countryside. The possession of a wide range of twenty or more clubs is further evidence of their centrality. Ashley is the only village which does not fit this pattern. It is not a well-developed service centre and it is rather less compact than the others, but it does contain some 800 people and it has experienced considerable expansion in recent years. The second group contains many different types of village offering a range of between fifteen and twenty clubs. Again, some of the villages are focal points for a comparatively wide area of countryside (eg. Hodnet and Bunbury), but in this group there are also suburban communities such as Barlaston and Shavington which are able to support a wide range of clubs by virtue of their large populations. A few villages, such as Whitmore (and Cheswardine in a lower group) appear to be able to support a large number of organisations in spite of their relatively modest population sizes and lack of obvious centrality, and here the reasons must be concerned with the readiness of local people to form clubs and the availability of suitable organisers.

The third group of villages, those with between ten and fifteen clubs is still composed mostly of large villages, although here again with such examples as Woore and Audlem centrality is obviously important. Many of the villages in this group have a poorly developed structure of social activity in relation to their population sizes and two reasons can be suggested. Firstly, a considerable number of these

villages have very close links with nearby towns; thetowns have a wide range of social attractions and therefore tend to upsurp some of the village functions. Secondly, many villages in this category contain large elements of newly settled population which have not yet had a chance to become fully integrated with the rest of the village. In these cases there will naturally be a time lag before full social equilibrium is established.

For smaller villages there is great variety in both the number of clubs and the population available to support them, and within this lower group there seems little point in distinguishing between the various villages, some of which may have five clubs and others four.

The growing mobility of rural populations, which arises from increased car ownership rates, means that people are becoming less tied to their own village. This has a dual effect in that social activities for the individual can now take place over a greater geographical range, but it also means that a village organisation can attract members from neighbouring villages. At present, most journeys are of fairly small distances and villages far from towns tend to have more organised clubs per hundred of their population than do villages close to towns.

Summarising then, there are five main factors which affect the number and range of social organisations in the villages of Staffordshire, north Shropshire and south Cheshire.

1. Population. Larger villages were found to have more clubs overall although less per hundred of their population than small villages. The types of clubs also vary with village size, smaller villages being more dependent upon the church and purely women's organisations.

2. Village Hall. The presence or absence of a village hall is an important factor in stimulating and maintaining a wide range of clubs and activities. In the same way other physical facilities

such as playing fields are important.

3. Centrality. The centrality of a village both affects and is in some part determined by its number of social organisations. Certain large size villages whose shops serve an area of four or five miles roundabout also contain a wide range of clubs and societies serving the surrounding area.

4. Leaders. The presence of suitable leaders or organisers make a great difference to village social life. In this context it is useful to refer to the booklet on Village Leadership produced by the Staffordshire Community Council. [7.]

5. Village social life is organised by andfor the people of the community — with them lies the responsibility for its success. The variation in the social structure of villages is ultimately determined by their population structure and the way in which the interests of the villagers are combined for organised social activites.

Table 5.14.

VILLAGES WHICH REPLIED TO THE QUESTIONNAIRE
Grouped according to their total number of clubs and societies

More than 20 organisations:

Ashley, Gnosall, Penkridge, Shifnal.

15-19 :

Barlaston, Bunbury, Haslington, High Ercall, Hodnet, Shavington, Shawbury, Whitmore.

10 - 14:

Audlem, Audley, Betley, Bickerton/Broxton, Cheswardine, Colwich, Eccleshall, Edgmond, Fulford Hinstock, Lapley/Wheaton Aston, Madeley, Upton Magna, Weston, Wistaston, Woore.

5 - 9:

Atcham, Barthomley, Basford/Chorlton/Hough, Blymhill, Brocton, Calverhall, Church Aston, Clive, Cotes Heath, Derrington, Great Bridgford, Great Haywood, Grinshill, Hadnall, Hilderstone, Hixon, Lilleshall, Maer, Norton-in-Hales, Oulton, Rodington, Sambrook, Seighford, Standon, Stanton-upon-Hine Heath, Stoke-upon-Tern, Tibberton, Wistanwick.

Less than 5:

Acton Trussel, Aston (by Pipegate), Berkswich, Blakenhall, Brindley/Faddiley, Chapel Chorlton, Church Eaton, Church Minshull, Hales, Hanchurch, High Hatton, Norbury, Onneley, Ranton, Stowe-by-Chartley, Wettenhall, Weston-under-Lizard, Weston-Redcastle, Yarnfield.

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Chapter 6 -

Hierarchies and the problem of hierarchical groupings.

One of the fundamental tenets in attempting to group a ranked array of settlements into discrete hierarchical tiers, or subsets, is that the resulting grouping is determined largely by the chosen method of producing it. Two problems confront the researcher. Firstly a method must be devised for ranking the settlements, and this has been described in preceding chapters. Secondly a technique must be derived, either for identifying the most realistic and consistent breaks in the rank list, or for measuring the loss of accuracy of description involved at each stage of a grouping procedure.

In discussing the recognition of hierarchical tiers in both human and physical geography Hagget [1.] suggests, "The basic difficulty both such studies face is their definition of breaks in the sequence, whether of function or terrain. In practice more or less arbitrary breaks have to be made." Unfortunately, although a hierarchical concept of the distribution of rank among central places is frequently accepted a priori, and has often been demonstrated to exist empirically in the literature, a specification of the hierarchy itself is all too often missing.

Until the early 1960s the most widespread methods of choosing grades within a hierarchy of central places appear to have had an intuitive basis: breaks were chosen at seemingly arbitrary or subjectively decided levels at the "best" or "most obvious" positions along the scale of functional complexity. The resulting groups were labelled major cities, minor cities, towns, villages etc., [(i)] or were given grades labelled by letters or numbers. The search for "natural breaks" was given further stimulus by the more objective

(i) Examples of the techniques and results of such treatment are given in chapter 1 and 2 pages.

approach of Clarke and Evans [2] who proposed that every member of a group should be closer to some other member of the group than to any other members of the ranked system. This definition was consolidated in its use for central place study by Berry and Garrison [3] in Snohomish County, Washington, and by Davies [4] in South Africa.

More recently the problems of grouping and numerical classification have received attention from a wide range of disciplines, including geography. At present there is no technique which can be universally accepted, even tentatively, as a "best method" for grouping central places. Often in the past hierarchical breaks have been identified within an array of scores that seek to quantify the totality of a settlement's functional provision. The replacement of a complexity of functional differences by a single numerical score involves considerable generalisation, but in an attempt — like the present one — to break away from single facet measures of centrality (e.g. retail equipment) a single numerical score based upon location coefficients does allow the addition and comparison of unlike attributes. In order to escape this possible criticism of overt generalisation, the literature of techniques has been searched for alternative approaches to the problem of grouping centres. Several different methods are briefly outlined below so far as they are relevant to the present study, but reference should be made to Appendix C where a more comprehensive bibliography of ranking techniques is included.

An implicit feature of the hierarchy of central places is that the higher members of the scale should possess the functions of the lower members, but not vice versa. Thus for a hierarchy based upon functional provision, settlements at each level should provide all of

the functions possessed by centres in groups lower than themselves, in addition to their own characteristic and distinctive provision.

Most of the techniques outlined here are based upon an iterative grouping procedure which progresses from complete specialisation, where n settlements occupy n groups, through intermediate steps whereby hierarchically adjacent settlements are progressively combined on the basis of measured similarities, to a final position of complete generalisation where all settlements have been combined into a single group. The techniques clearly distinguish not a single definite hierarchy, but give many possible statements of the hierarchy. It is only the increasingly widespread use of high speed computers in the past decade which has made the development of this type of grouping method feasible.

Cluster analysis is a grouping method of this kind, and although it has not been extensively used by geographers, Berry [5] used it to group a number of regions into a smaller number of subsets, and it was one of the techniques used by Mayfield [6] to identify a functional hierarchy of settlements in N. India. No method of grouping devised to date will identify the presence or absence of natural groups or associations of individuals, but cluster analysis, like the other procedures discussed will produce a hierarchical set of groups if the researcher is looking for one.

A range of other multivariate methods to produce a series of groups with maximum internal homogeneity and between-groups dissimilarity has also been used in a central place context. Complex matrices of settlements with measured functional variables have been reduced to more simple forms and examined for evidence of grouping tendencies.

For example Berry and Barnum[7] used both principal components analysis and factor analysis in a study of the settlement pattern of southwest Iowa. They came to the conclusion that a continuum of settlements existed in aggregate, but that a hierarchy could be identified at a more local level.[8]

Further discussion on methods of deriving multifactor uniform groups which have relevance to the problem of identifying hierarchies, or groups of central places, is provided by Pocock and Wishart.[9] They examine two fusion methods whereby a list of units is reduced stepwise to a single group by the systemmatic amalgamation of similar samples. When two or more samples are fused into a subset, that subset is considered as a single unit located at the centroid of its constituent members.

Pocock and Wishart termed their preferred solution the Dense Space method. Points were located in a space according to their measured characteristics, and the space was searched for dense spheres representing important concentrations of uniform units. Distinct regions were then formed by linking any spheres which intersected. Two disadvantages restrict the usefulness of this method as a tool for central place study. It is quite possible for individual points to be omitted from the groups thus formed, and secondly the importance of each group is dependent upon the number of points which it contains.

It is clear that any central place hierarchy should include all the members submitted for grouping, and the essence of the hierarchy is that the higher groups should contain a smaller number of members than lower groups, so reflecting the pyramid of functions, but the upper groups should not be considered less

important thereby.

A method of grouping which appears to have considerable objective appeal and one which has found some use by geographers is that derived by Ward.[10] By Ward's method an initial list of n exclusive subsets each with a single numerical index is combined step by step eventually into a single group. At each stage the union of all possible subsets into pairs is considered in such a manner that the two most similar subsets are chosen for combination. Similarity in this context is measured in terms of the Error Sum of Squares (ESS) where

$$ESS = \sum_{i=1}^{n} X_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} X_i\right)^2$$

x = the score of the ith individual

This grouping procedure was chosen from the range of possible procedures reviewed as one likely to be particularly useful, and it was applied to all of the settlements in the study area. Each settlement had a single numerical score based upon its functional complexity, and calculated as the sum of centrality values in Table 3.1. It has already been suggested in this chapter that this expression of the settlement's functional totality as a single score involves extensive generalisation, but this weakness (if indeed it be a weakness) is outweighed by the method's advantages. By summing the centres unlike attributes in the form of a single score, the full range of settlements down to the small and functionally rudimentary centres, can be considered for hierarchical division, and this gives a breadth of operation not possible with many alternative techniques. Furthermore the procedure utilised here produces not only a logical statement of the hierarchy divided to the limits of meaningful classification, but also a measure of confidence or accuracy in making each inter-group distinction. Thus several alternative statements of the hierarchy are provided, which the reader or user can select for his specific purposes, depending upon the level of confidence he requires.

Ward's grouping method was reprogrammed for processing on the University of Keele's computer, and the revised program is given in Appendix D. The mechanics of the operation are briefly as follows:-

> Commence with N subsets where each subset is the functional score of a single settlement, and N = 200.
>
> Step 1. Amalgamate all settlements with equal scores into an appropriate number of groups. The result is n groups where $n < N$.
>
> Step 2. Select two subsets such that when grouped together they cause the least loss of detail, i.e. such that ESS is minimised. Result is (n - 1) subsets.
>
> Step 3. Examine the (n - 1) subsets to determine the next grouping which will bring about the smallest increase in ESS. This may be (a) by joining two individuals into a pair, (b) joining an individual with a multiple subset formed at an earlier stage, or (c) joining two multiple subsets.
>
> Step 4. Repeat step 3 until all subsets are members of one large group at which point a position of complete generalisation will obtain.

A crucial point, as with many grouping procedures, is that this method will not divide a list of settlements into a single definite pattern of hierarchical groups. What it does achieve however is the identification of the relative significance of the gaps between adjacent settlements in the list; 200 settlements can be divided into anything between 1 and 200 groups. The final choice of a particular statement of grouping as the best for the hierarchy under review, i.e. how many breaks are necessary and at what stage to arrest the grouping procedure is still a decision that must be made empirically.

In some respect then this method is an illustration of the dictum that a hierarchy may always be found amongst a set of data if such a hierarchy is being sought.

The final 20 cycles of the print out of the grouping procedure is shown in Table 6.1 . From left to right this indicates the cycle number, an identifier for one of the groups about to be amalgamated

Table 6.1 Final twenty cycles of the Grouping Procedure. Numerical Scores.

Cycle Number	I set reference number	Number of items in I set	J set reference number	Number of items in J set	Error Sum Squares
170	264	3	271	32	143.217146
171	17	2	16	2	188.644739
172	23	5	45	6	258.951962
173	9	1	5	1	418.978009
174	264	35	115	122	582.053495
175	26	2	18	1	814.308307
175	4	1	8	1	1085.054769
177	6	1	9	2	1687.256785
178	15	5	23	11	2403.174191
179	12	1	2	1	3231.012238
180	3	1	10	1	4370.566039
181	26	3	17	4	6083.286153
182	15	16	264	157	10628.522130
183	12	2	6	3	18824.096212
184	1	1	3	2	33028.923482
185	26	7	15	173	64998.010382
186	7	1	4	2	102133.397217
187	1	3	12	5	196311.422738
188	7	3	1	8	726391.317813
189	7	11	26	180	2758720.500560

END

Table 6.1 (continued) Final twenty cycles of the Grouping Procedure. Log. Scores.

Cycle Number	I set reference number	Number of items in I set	J set reference number	Number of items in J set	Error Sum Squares
170	111	14	66	18	0.181264
171	3	2	12	2	0.207340
172	58	9	121	21	0.241815
173	69	19	246	18	0.276916
174	23	5	45	6	0.333503
175	26	3	17	4	0.391940
176	264	3	271	8	0.462689
177	108	8	175	2	0.546213
178	3	4	6	3	0.639042
179	69	37	61	17	0.805844
180	264	11	252	20	1.036857
181	15	5	23	11	1.334263
182	58	30	111	32	1.670911
163	7	4	3	7	2.153635
184	69	54	108	10	2.900976
185	26	7	15	16	4.545052
186	264	31	58	62	6.276889
187	264	93	69	64	11.632760
188	7	11	26	23	21.301882
189	7	34	264	157	88.979537

END

Table 6.1(a)

7	Shrewsbury	63	Bunbury	259	Whitmore
4	Newcastle	195	Prees	58	Brocton
8	Stafford	264	Wistaston	82	Clive
1	Crewe	135	Hixon	87	Cotes Heath
3	Nantwich	122	Halmer End	92	Croxton
10	Wellington	271	Wrenbury	115	Great Bridgeford
12	Whitchurch	36	Ashley	197	Prees Higher Heath
2	Market Drayton	158	Loggerheads	98	Dunston
6	Oakengates	100	Edgmond	110	Gailey
9	Stone	253	Weston-under-Lizard	32	Albrighton
5	Newport	134	Hinstock	121	Hales
26	Shifnal	251	Weston (Crewe)	213	Seighford
11	Wem	126	Haughton	176	Mucklestone
18	Donnington	252	Weston-under-Trent	221	Standon
17	Hadley	268	Woodeaves	62	Bulkeley
19	Penkridge	236	Tittensor	139	Hopton
16	Eccleshall	231	Swynnerton	42	Baldwins Gate
13	Audley	272	Wrockwardine	249	Waters Upton
15	Gnossal	53	Blyth Bridge	219	Spurstowe
22	Shavington	34	Alsager Bank	161	Loppington
14	Bignall End	270	Worleston	256	Wetwood
20	Audlem	171	Milford	273	Wybunbury
25	Shawbury	129	High Ercall	76	Cholmondley
23	Willaston	73	Cheswardine	226	Stowe-by-Chartley
269	Moore	59	Bromstead Heath	238	Tong Norton
163	Madeley	209	Sandon	170	Miles Green
21	Haslington	245	Walton	232	Tern Hill
117	Great Haywood	33	Alpraham	166	Marbury-cum-Quoisley
45	Barlaston	79	Church Eaton	109	Fulford
24	Hodnet	267	Wood Lane	37	Ash Magna
257	Wheaton Aston	189	Oulton	145	Knightley
48	Betley	133	Hilderstone	111	Gallantry Bank

262 Winterley
206 Rodington
184 Norton-in-Hales
233 Tibberton
120 Radnall
52 Blymhill
235 Tilstock
80 Church Minshull
74 Childs Ercall
200 Preston Weald Moors
27 Acton
174 Moreton Corbet
261 Whixall
66 Burleydam
146 Knighton (Maer)
114 Grinshill
96 Derrington
222 Stanion-upon-Hine-Heath
153 Lilleshall
274 Yarnfield
41 Aston (Maer)
182 Norbury (Staffs)
144 Keele
105 Faddiley
72 Chebsey
241 Upton Magna
142 Ightfield
93 Crudgington
141 Hyde Lea
47 Bednall
156 Little Madeley
69 Calverhall
218 Sound
125 Hatherton
55 Bradley
83 Cold Hatton
154 Little Haywood
30 Adderley
225 Stoke-upon-Tern
205 Ranton
247 Warmingham
114 Great Bolas
124 Hankelow
40 Aston
199 Preston Brockhurst
29 Adbaston
215 Sherrifhales
227 Stretton
131 High Offley
223 Stapeley
246 Wardle
263 Wistanwick
254 Weston-under-Redcastle
28 Acton Trussel
46 Barthomley
185 Norton Bridge
265 Withington
217 Slindon
132 High Onn
237 Tixall
140 Hough
196 Prees Green
43 Balterley
193 Platt Lane
77 Chorley
116 Great Chatwell
172 Milwich
50 Bishops Offley
61 Buerton
164 Maer
78 Church Aston
54 Bradfield Green
31 Admaston
102 Ellenhall
104 Eyton-upon-the-Weald Moors
148 Kynnersley
173 Moddershall
240 Uffington
260 Whitgreave
266 Wollerton
147 Knighton
101 Ellerdine Heath
64 Bunbury Heath
84 Colwich
208 Sambrook
108 Fradswell
151 Lee Brockhurst
194 Poynton Green
187 Onneley
224 Steel Heath
123 Hanchurch
56 Brindley
113 Gayton
175 Moreton Bay
71 Chapel Chorlton

(the i set), the number of items in the i set, an identifier for the second group of the pair being combined (the j set) and the number of items in the j set. The final column indicates the ESS at each stage. (The reference numbers to identify the settlements are the same as those in Table 6.1(a)). Thus in the final row of Table 6.1 i.e. cycle 189, the i set consisting of Shrewsbury (No.7) and the 33 succeeding settlements is combined with a j set comprising Wistaston (No.264) and the other 156 settlements.

Table 6.2 lists all of the settlements which were submitted for grouping in descending order of functional scores, the position of the breaks identified and the relative importance of each break. The most significant gap, i.e. the last one which would be bridged to produce a single class if the grouping procedure was followed through to its conclusion, is that between Newport and Shifnal. This gap effectively is the division between settlements which above are "towns", or at least have urban characteristics, and those below which are villages. In fact below this point the smaller settlements are only divided once more; into a mixed group of seven large suburban and central villages and another composed of the other 173 settlements.

Shrewsbury, an important market, retail, service and county centre is supreme in the list and is alone as a grade 1 centre, Newcastle and Stafford follow as group 2 and then Crewe as a single grade 3 centre. Judged solely by population there is a big jump from Crewe, in group 3, with 53,200 people, to Nantwich and Wellington in group 4 with populations of 10,438 and 13,654, but they are separated by a relatively unimportant break in Table 6.2. Whitchurch and Market Drayton stand together in group 5 as market towns less functionally complex and less populous than those of group 4, but due to their relative spatial isolation they are able to support functions which raise them

Table 6.2 Settlements grouped according to their functional score (Numerical)

RANK		RELATIVE IMPORTANCE OF BREAK
1	Shrewsbury	4
2	Newcastle	
	Stafford	2
3	Crewe	6
	Nantwich	
4	Wellington	3
	Whitchurch	
5	Market Drayton	7
	Oakengates	
6	Stone	
	Newport	1
	Shifnal	
	Wem	
	Donnington	
7	Hadley	
	Penkridge	
	Eccleshall	
	Audley	5
	Gnossal	
	Shavington	
	Bignall End	
	Audlem	
	Shawbury	
	Willaston	
	Woore	
	Madeley	
	Haslington	
	Great Haywood	
	Barlaston	
	Hodnet	
	Wheaton Aston	
	Betley	
	Bunbury	
	Prees	
	Wistaston	
	Hixon	
	Halmer End	
8	Wrenbury	
	Ashley	
	Loggerheads	
	Edgmond	
	Weston-under-Lizard	
	Hinstock	
	Weston (Crewe)	
	Haughton	
	Weston under Trent	
	Woodeaves	
	Tittensor	
	Swynnerton	
	Wrockwardine	
	Blyth Bridge	
	Alsagers Bank	
	Worleston	
	Milford	
	High Ercall	
	Cheswardine	
	Bromstead Heath	
	Sandon	
	Walton	
	Alpraham	
	Church Eaton	
	Wood Lane	
	Oulton	
	Hilderstone	
	Whitmore	
	Brocton	
	Clive	
	Cotes Heath	
	Croxton	
	Great Bridgeford	
	Prees Higher Heath	
	Dunston	
	Gailey	
	Albrighton	
	Hales	
	Seighford	
	Mucklestone	
	Standon	
	Bulkeley	
	Hopton	
	Baldwins Gate	
	Waters Upton	
	Spurstowe	
	Loppington	
	Wetwood	
	Wybunbury	
	Cholmondley	
	Stowe by Chartley	
	Tong Norton	
	Miles Green	
	Tern Hill	
	Marbury cum Quoisley	
	Fulford	
	Ash Magna	
	Knightley	
	Gallantry Bank	
	Winterley	
	Rodington	
8	Norton in Hales	
	Tibberton	
	Hadnall	
	Blymhill	
	Tilstock	
	Church Minshull	
	Childs Ercall	
	Preston Weald Moors	
	Acton	
	Moreton Corbet	
	Whixall	
	Burleydam	
	Knighton (Maer)	
	Grinshill	
	Derrington	
	Stanton upon Hine Heath	
	Lilleshall	
	Yarnfield	
	Aston (Maer)	
	Norbury (Staffs)	
	Keele	
	Paddiley	
	Chebsey	
	Upton Magna	
	Ightfield	
	Crudgington	
	Hyde Lea	
	Bednall	
	Little Madeley	
	Calverhall	
	Sound	
	Hatherton	
	Bradley	
	Cold Hatton	
	Little Haywood	
	Adderley	
	Stoke upon Tern	
	Ranton	
	Warningham	
	Great Bolas	
	Hankelow	
	Aston	
	Preston Brockhurst	
	Adbaston	
	Sherrifhales	
	Stretton	
	High Offley	
	Stapeley	
	Wardle	
	Wistanwick	
	Weston under Redcastle	
	Acton Trussel	
	Barthomley	
	Norton Bridge	
	Withington	
	Slindon	
	High Onn	
	Tixall	
	Hough	
	Prees Green	
	Balterley	
	Platt Lane	
	Chorley	
	Great Chatwell	
8	Milwich	
	Bishops Offley	
	Buerton	
	Maer	
	Church Aston	
	Bradfield Green	
	Admaston	
	Ellenhall	
	Eyton-upon-the Weald Moors	
	Kynnersley	
	Moddershall	
	Uffington	
	Whitgreave	
	Wollerton	
	Knighton	
	Ellerdine Heath	
	Bunbury Heath	
	Colwich	
	Sambrook	
	Fradswell	
	Lee Brockhurst	
	Poynton Green	
	Onneley	
	Steel Heath	
	Hanchurch	
	Brindley	
	Gayton	
	Moreton Say	
	Chapel Chorlton	

above Oakengates, Stone, and Newport in group 6. These latter three towns suffer greatly from competition from nearby superior centres.

The lack of definition between settlements at the lower end of the scale (coupled perhaps with over-division at the upper end) is an evident fault of table 6.2. Much of the reason for this can be attributed to the "swamping" of the scores of small centres by those of large ones, so the program was run a second time, but now with functional scores transformed logarithmically. This was not just a mathematical device, it was introduced to retain the significance of the ratio between raw score differences and the actual scores throughout the scale.

This time the results were as in Table 6.3. and it will be seen that the positions of the hierarchical group boundaries differ considerably from those in table 6.2. The fundamental discontinuity (i.e. the last to be closed by progressive grouping) is between Prees and Wistaston. This represents a break in both retail and service provision, but of these the former is the more significant. Settlements above this break, with only minor exceptions, have functions representing all of the categories of retail and service provision listed in Table 3.3., i.e. food, clothing, hardware, other retail, profession/financial services, personal services and county services. The functions represented in settlements below the break are confined almost entirely to the food shop and county service categories. Thus the log transformation identifies a crucial 'real' step in the order of centrality, between relative completeness and incompleteness of retail provision. This is a re-statement of the distinction between centres offering only convenience goods and those with a wider range of retail facilities.(i)

In table 6.3. the gap between Newport and Shifnal (virtually the town- subtown division) is again a prominent one, and in contrast

(i) This was discussed in chapter 4 pages 95-96.

Table 6.3 Settlements grouped according to their functional score (Logarithmic)

RANK		RELATIVE IMPORTANCE OF BREAK
	Shrewsbury	
1	Newcastle	
	Stafford	
	Crewe	7
	Nantwich	
	Wellington	
	Whitchurch	
2	Market Drayton	
	Oakengates	
	Stone	
	Newport	2
	Shifnal	
	Wem	
	Donnington	
3	Hadley	
	Penkridge	
	Eccleshall	
	Audley	5
	Gnossal	
	Shavington	
	Bignall End	
	Audlem	
	Shawbury	
	Willaston	
	Woore	
	Madeley	
4	Haslington	
	Great Haywood	
	Barlaston	
	Hodnet	
	Wheaton Aston	
	Betley	
	Bunbury	
	Prees	1
	Wistaston	
	Hixon	
	Halmer End	
	Wrenbury	
	Ashley	
	Loggerheads	
	Edgmond	
	Weston-under-Lizard	
	Hinstock	
	Weston (Crewe)	
	Haughton	
	Weston under Trent	
	Woodeaves	
	Tittensor	
	Swynnerton	
	Wrockwardine	
5	Blyth Bridge	
	Alsagers Bank	
	Worleston	
	Milford	
	High Ercall	
	Cheswardine	
	Bromstead Heath	
	Sandon	
	Walton	
	Alpraham	
	Church Eaton	
	Wood Lane	
	Oulton	
	Hilderstone	
	Whitmore	4
	Brocton	
	Clive	
	Cotes Heath	
	Croxton	
	Great Bridgeford	
	Prees Higher Heath	
	Dunston	
	Gailey	
	Albrighton	
	Hales	
	Seighford	
	Mucklestone	
	Standon	
	Bulkeley	
	Hopton	
	Baldwins Gate	
	Waters Upton	
	Spurstowe	
	Loppington	
	Wetwood	
	Wybunbury	
	Cholmondley	
	Stowe by Chartley	
	Tong Norton	
	Miles Green	
	Tern Hill	
	Marbury cum Quoisley	
	Fulford	
	Ash Magna	
6	Knightley	
	Gallantry Bank	
	Winterley	
	Rodington	
	Norton in Hales	
	Tibberton	
	Hadnall	
	Blymhill	
	Tilstock	
	Church Minshull	
	Childs Ercall	
	Preston Weald Moors	
	Acton	
	Moreton Corbet	
	Whixall	
	Burleydam	
	Knighton (Maer)	
	Grinshill	
	Derrington	
	Stanton upon Hine Heath	
	Lilleshall	
	Yarnfield	
	Aston (Maer)	
	Norbury (Staffs)	
	Keele	
	Faddiley	
	Chebsey	
	Upton Magna	
	Ightfield	
	Crudgington	
	Hyde Lea	
	Bednall	
	Little Madeley	3
	Calverhall	
	Sound	
	Hatherton	
	Bradley	
	Cold Hatton	
	Little Haywood	
	Adderley	
	Stoke upon Tern	
	Ranton	
	Warningham	
	Great Bolas	
	Hankelow	
	Aston	
	Preston Brockhurst	
	Adbaston	
	Sherrifhales	
	Stretton	
	High Offley	
	Stapeley	
	Wardle	
	Wistanwick	
	Weston under Redcastle	
	Acton Trussel	
7	Barthomley	
	Norton Bridge	
	Withington	
	Slindon	
	High Onn	
	Tixall	
	Hough	
	Prees Green	
	Balterley	
	Platt Lane	
	Chorley	
	Great Chatwell	
	Milwich	
	Bishops Offley	
	Buerton	
	Maer	
	Church Aston	
	Bradfield Green	
	Admaston	
	Ellenhall	
	Eyton-upon-the Weald Moors	
	Kynnersley	
	Moddershall	
	Uffington	
	Whitgreave	
	Wollerton	
	Knighton	
	Ellerdine Heath	
	Bunbury Heath	
	Colwich	
	Sambrook	6
	Fradswell	
	Lee Brockhurst	
	Poynton Green	
	Onneley	
	Steel Heath	
8	Hanchurch	
	Brindley	
	Gayton	
	Moreton Say	
	Chapel Chorlton	

to table 6.2. there is more division at the lower end of the scale and less at the top. The groups which form this hierarchical structure, together with some of their characteristics are outlined below. (Table 6.4). The adjectives applied to each group should be taken for descriptive purposes, and not as definite titles.

Table 6.4.

Group	Description	Number of Members		Average population	Average No. of shops.
1	district centres	4		56,575	666
2	market towns	7	14	8,929	148
3	central villages	7		3,492	34.4
4	grade A villages	16	47	1,469	10.4
5	grade B villages	31		605	2.6
6	grade C villages	62		237	1.5
7	grade D villages	54	126	175	0.8
8	hamlets (i)	10		124	0.6

This hierarchy does not accord perfectly with the the fixed k assumption of classical central place theory, but if the divisions are grouped as indicated by the brackets in table 6.4 there is a tendency to follow a bifurcation ratio of k = 3. Thus, given four centres of highest order, twelve would be predicted at the next level where in fact fourteen are found. From fourteen at this level, 42 would be expected below, instead of the 47 which occur, and at the lowest level 141 (cf 126) would be anticipated.

The kinds of centres which constitute each of these groups differs considerably in their size and range of functional provision. In order to elucidate these differences a brief profile of each group is given below .

(i) Since a minimum functional constraint was placed upon settlements included for examination, many of the smallest hamlets have been omitted.

Group 1These are the four largest towns in the area, i.e Newcastle, Stafford, Crewe and Shrewsbury. They all have clearly defined central shopping areas and peripheral suburban shopping facilities. In the central area food shops are heavily outweighed by non-food shops and many kinds of specialised shops,(1) department stores and chain or multiple shops are represented. Two county towns are included in the group and with an average population of approximately 56,000 each of these centres has a large shopping, service, entertainment and employment area. Many units of each of the listed services are present and frequently these towns serve as area headquarters for private and public organisations. New retail development is extensive in all of the towns and it is characteristically supported by multi-storey carparking facilities. New development takes the form of both extensive projects (e.g. Shrewsbury's "Riverside" development) and in-filling of valuable town centre sites. Invariably the outskirts of the CBD are dominated by small, shoddy buildings, and the CBD show the typical outward progression from the PLVI dominated by department stores, multiples and banks, through the smaller, but still 'central' private and multiple stores to the small bric-a-brac, antique, delicatessan, cycle shops, pet stores and used car lots on the periphery. Each town has an important livestock, produce and general merchandise market and is an important district centre. In these centres small suburban retail nodes have developed, typically with no more than half a dozen shops providing 'convenience goods' for a localised suburban population.

Group 2. A group of seven well established market towns with an average population of nearly 9,000. Each has a clearly defined central shopping area, usually at the junction of several important roads where one street dominates. Many are picturesque, and modern development is mostly very modest being confined to one or two new replacement units

(1) In this general context 'specialised' shops are taken to mean high order shops providing usually a single narrow range of goods; e.g. photographic equipment, office furniture, paintings and artists' materials, etc.

in prime sites.(The exception is Oakengates where a modern precinct of some 30 units is largely still vacant after three years). Non food shops still predominate over foods shops in the central area, although there are a few medium sized supermarkets. Privately owned and multiple shops selling clothes and household goods are well represented and all centres can boast a range of specialist shops (e.g. photographic, music garden stores). "Suburban" retail development is limited forthe most part to individual convenience shops. These towns are important centres for farming population, and each has a market which figures prominantly in the local economy. With only minor exceptions each town in this group possesses a full range of the services listed.

Group 3. Two kinds of settlements comprise this group, on the one hand there are the large 'central villages' of Shifnal, Wem, Penkridge, and Eccleshall, and on the other hand are the substantial suburban settlements of Donnington, Hadley and Audley. The former tend to be smaller, with an average population of 2,225 and rely upon their central position for their status, whilst the latter although close to a larger settlement have a comparable shopping and service provision to serve their larger average population of 4,900. In the central village group non food shops predominate over food shops, but in the suburban settlements the two are equally represented. In both cases the non food shops are mostly clothing and household goods and multiple stores are rare, as are specialised shops. The central area is characteristically weakly developed, and is dominately by a single street. Services are not well developed although again the "central villages" do rather better than the suburbs. Typically a post office, bank and doctor are present as are a ladies hairdresser, dry cleaner, primary and secondary schools, a mobile library and a police station not continuously manned. Most of the shop units are small and have old-fashioned frontages although some small modern food supermarkets are to be found. It is at this level, and below, that social activities become important as an element of centrality as discussed in chapter 5. In Group 3 representatives of

each type or activity, i.e. church based, womens', sporting, young peoples' and miscellaneous clubs and organisations occur frequently.

Group 4. A group of important villages which again have prospered (in a relative sense) due either to urban proximity or a central position. The average population is nearly 1,500 although this ranges from Bunbury (355) to Shavington (3,300). These villages have between seven and 20 shops, typically about ten, with food shops slightly better represented than non food. Individual units are small although many have been purpose built quite recently. The shops of villages of this order provide mostly everyday convenience goods and the typical complement might be five general food shops providing a range of groceries, frozen and occasionally fresh vegetables, one butcher, one confectioner/newsagent/tobacconist, one village draper/general clothing shop, one small footwear shop, one hardware shop and a small chemist. Service provision is fairly restricted, although county services are widely represented. All of the villages have a post office and a primary school, more than three quarters have a doctor, a ladies hairdresser, a district nurse, a visit from a mobile library and a police house, and in descending order of importance, banks, turf accountants, secondary schools and dry cleaners are also represented. Shops are generally small and old-fashioned, but occasionally where a village has a substantial commuter element, a few new units have been erected e.g. at Madeley and Great Haywood.

Group 5. The villages in this group have an average population of approximately 600 and the maximum number of shops is seven, with food shops always predominating. Two-thirds of the villages have no shops in the non food category but the few examples which exist are tobacconist/newagents, hardware and general clothing stores. Many of these settlements have experienced considerable recent population growth due to the increase in daily commuting to nearby towns (e.g. Ashley, Edgmond

Haughton). A large number of the villages have grown up by virtue of their central position in regard to the local road network, but their range of retail and service facilites is so limited that none of them are truly central villages today. Service facilities possessed by villages in this group were found to be limited, and as with all of the smaller villages it is the county services which are most widespread. With only very few exceptions villages in this group have a post office and a stopping point for the mobile library. About one-third possessed a police house, a primary school and a ladies hairdresser, and other services which are represented are doctors, district nurse and secondary school. Private and commercial services are poorly represented and it is rare for a settlement in this group to possess more than one unit of any particular service.

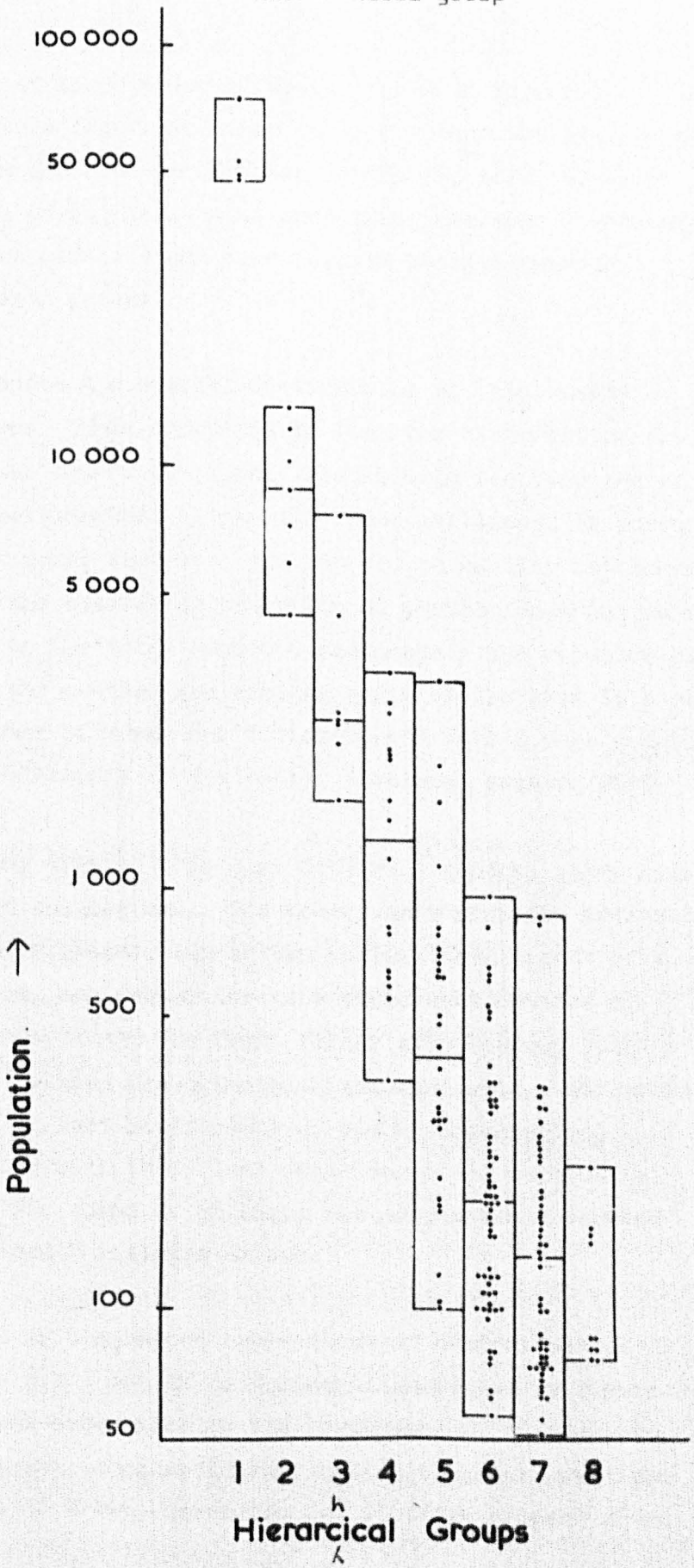
Group 6. This is a large group of small villages (average population 230) which with only minor exceptions can boast some measure of retail, professional and commercial or county based services. One-third of the villages have more than one shop, but only one non food shop is found in the whole group of 62 settlements. The typical profile of a village in this group therefore is of one with a population of approximately 230, possessing one or two general food stores, a post office (incorporated in the shop), commonly a primary school and a police house and in a fifth of cases a district nurse. Rarely a doctor may also be found.

Group 7. Another large group of small villages (average population 175) relying for their functional status upon county provided services (e.g. a primary school, a police house or a stopping point for the mobile library), and the possession of a village hall and associated social activities. Shops, where they occur, are exclusively of the general store type, with a heavy emphasis on food.

Group 8. A 'sump' group of very small villages and hamlets, frequently in fact no settlement as such can be recognised, the name refers to a locality, perhaps just a shop at a cross roads, and a point where the mobile library stops.

The population ranges of settlements, and the progressively lower

Figure 6.1 The population range of settlements in each hierarchical group



median population of lower order groups is shown in Figure 6.1. It can be seen from this figure and from Table 6.4 that the average and median populations for each hierarchical group are quite distinct although the range of populations of individual members in each group, especially at lower orders shows considerable overlap between functionally distinct groups.

Figure 6.2 shows the spatial distribution of settlements at each of these orders. This demonstrates that the distribution of centres at the lower orders is closely linked with the location of the higher order settlements: each high order settlement is surrounded by a system of low order centres. The pattern of smaller settlements closely parallels the overall distribution of population, which is itself a response to the total economic landscape. The relative paucity of settlements in the central and western parts of the area is contrasted with a greater number of towns and villages, and both a more complex and more complete hierarchy in the better developed eastern part.

Even in a study area of this size different central place systems exist in contrasted sub-regions. The areas containing the greatest number of towns and villages, and so the fullest development of a central place system, are around the main employment centres of Wellington/Oakengates, along the Trent Valley axis between Stafford and Newcastle, and between Crewe/Nantwich and Newcastle. The mainly agricultural areas of west Staffordshire, south Cheshire and north west Shropshire with their less dense spread of population, support relatively few towns or villages and only a basic service network of grade 6 and 7 villages exists.

This existence of contrasted sub-systems of central places is evident from Figure 6.2., but it is further illustrated by Figure 6.3. This figure indicates schematically the occurrence of settlements of each order in the areas immediately surrounding the four grade one centres. The towns of Crewe, Newcastle and Stafford are each shown to

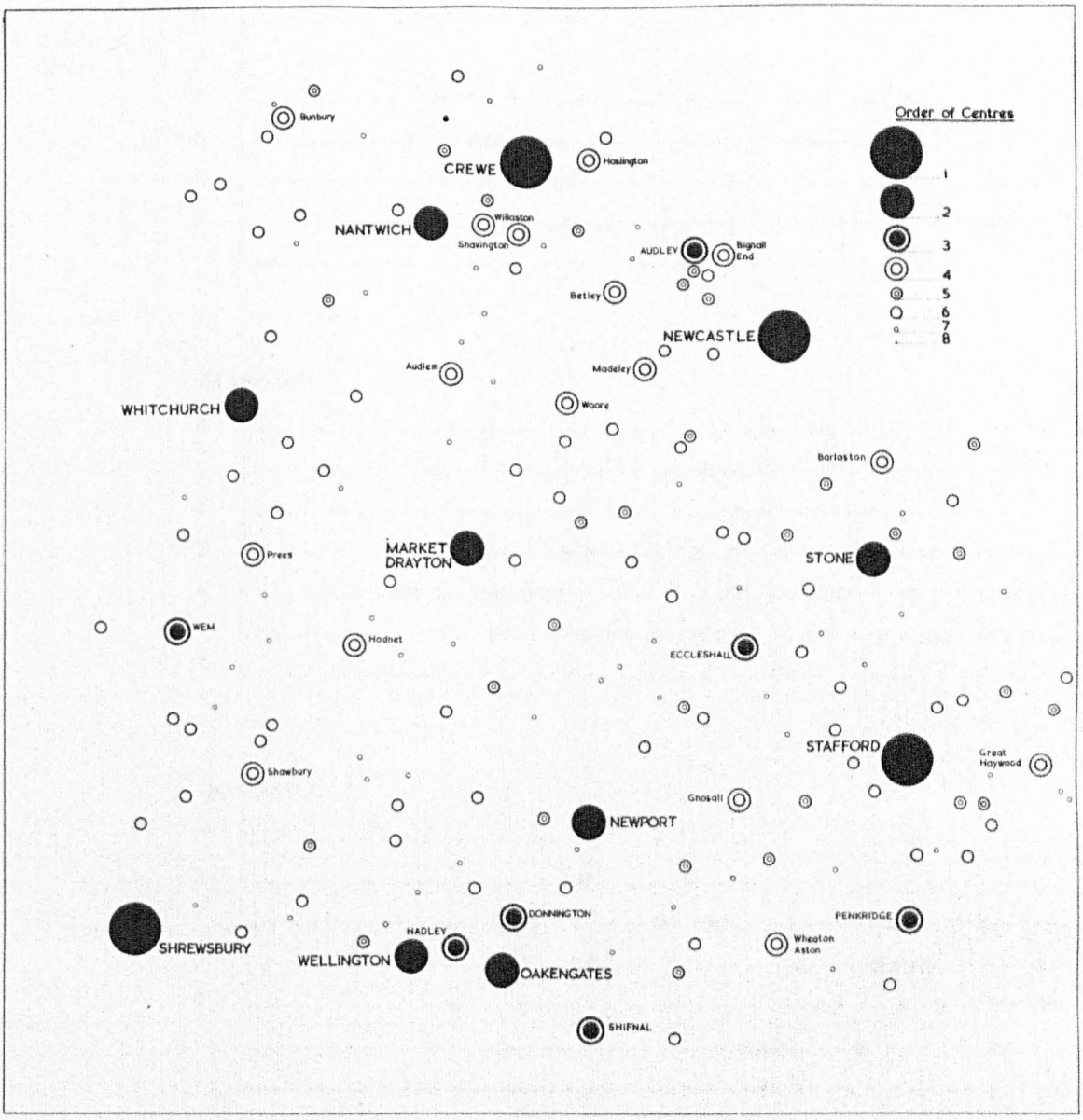


Figure 6.2 The distribution of settlements in each hierarchical group

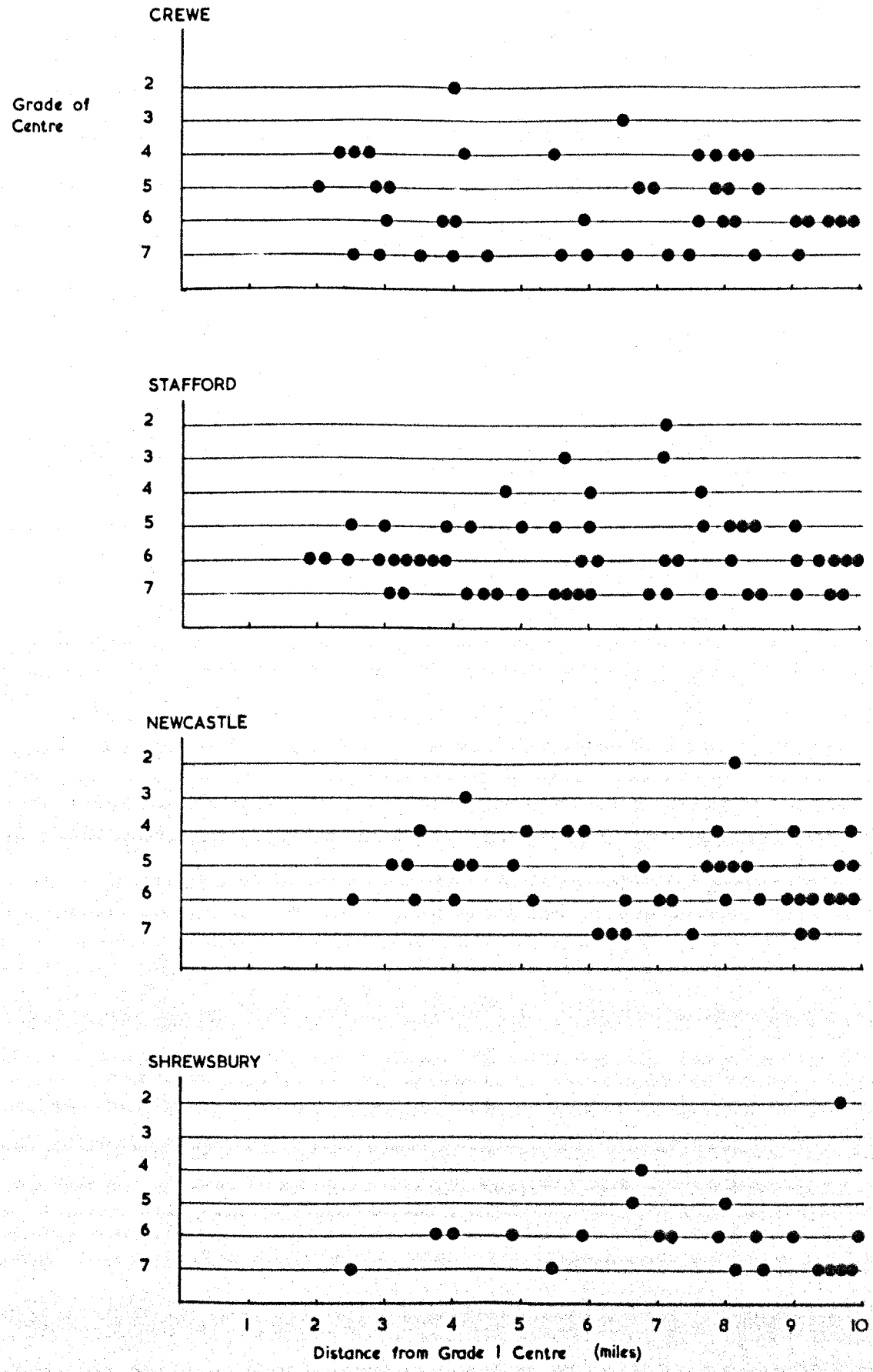


Figure 6.3 Central place sub-systems in relation to grade 1 centres

be surrounded by a relatively dense network of settlements ranging from grade 2 towns and increasing in number consistentlydown the scale. In the more sparsely settled south west however Shrewsbury is surrounded by a much smaller number of settlements, and these are mostly concentrated in orders 6 and 7.

The methodology outlined above has therefore been found to work successfully, in that it has indicated the position and relative importance of discontinuities in a list of settlements ranked according to their functional provision. We were looking for an objectively determined hierarchy of settlements, and one was found, but we must note that the groups found here would not necessarily accord with those identified elsewhere by the same method, or by other methods in our area. Either by moving, or extending the area of investigation, other centres might be found which would change the position of the group boundaries, or even slot into place between the gaps which have been established, and so change the entire system.

Is there then any justification in seeking hierarchies of central places on anything less than a national scale? In addition it would be a mistake to think that any groups which have been identified are necessarily static; the work of Smith [11] in Wales is but one example of the movement of central places from one group into a higher or lower level with the passage of time, and this inevitably creates a blurring of inter-group boundaries.

One weakness of the above method for the identification of hierarchical groups is that it does not take into account the spread of retail and service provision in each centre, but only the net result expressed as a numerical score. Although this score is itself an index derived from a centre's total mix of functions it is theoretically possible for two centres with quite dissimilar functional attributes to have an identical score. In practise towns and villages of comparable

size were found to have broadly similar functional profiles, but a detailed comparison of these profiles would provide a sensitive measure of hierarchical similarities. Such a method for establishing groups of settlements has been used by W.K. Davies [12] in South Wales, and more recently by O'Farrell [13] in Ireland. Central places were ranked according to their total score computed from the functional matrix, raw scores in each column of functional type were converted into ranks and adjacent pairs of settlements were compared in respect of their overall functional provision by means of Spearman coefficients of association.

This approach to an urban hierarchy by distinguishing inter-group differences and within group similarities is demonstrated in Table 6.5. Five groups have been distinguished but it can be seen that the description at the lower end of the scale is poor, and that below the village of Haslington all settlements are included in a single group. The utility of grouping centres in this fashion is thus seen to be limited to relatively large and functionally complex settlements; at lower levels the method is not statistically sound and small settlements with simple functional arrays cannot be differentiated.

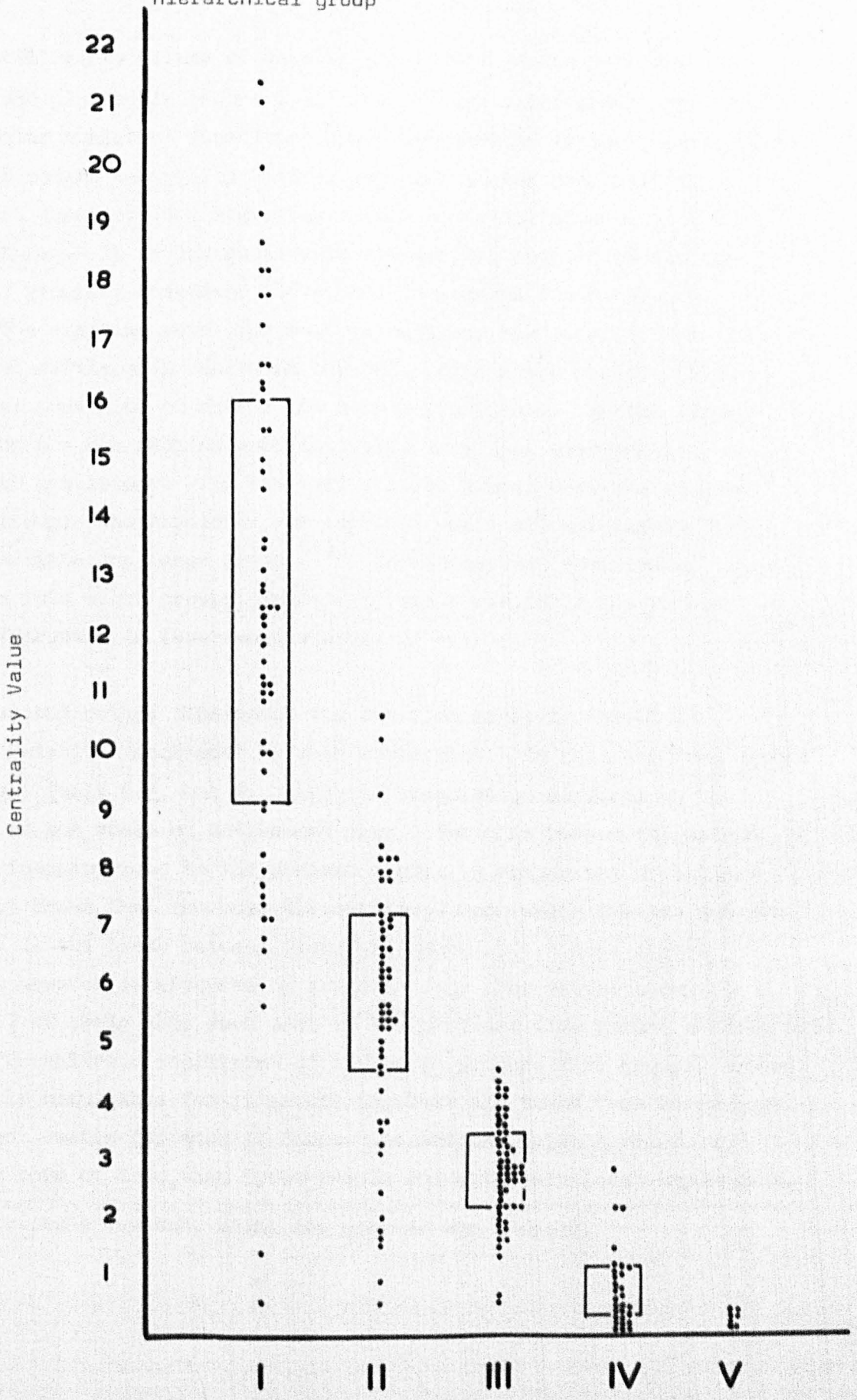
In Table 6.5. Shrewsbury, Stafford, Newcastle and Crewe emerge in group 1 and these may be described as district centres. Group 2 is a fairly straight forward group of market towns, but group 3 is a mixture of small towns central villages and suburban settlements. Group 4 comprises mostly large commuter villages and group 5 is all other settlements.

Adhering strictly to the linkages indicated by Spearman Rank Correlation Coefficients there should be further breaks as indicated by asterisks in Table 6.5, however by testing extreme members of groups for similarity these breaks were found to be illogical. Thus Oakengates was found to be more like Donnington than it was like Wem, so the breaks were omitted.

Table 6.5 Hierarchical Grouping of Settlements : Method 2 (After W K Davies)

	Settlement	Rank Correlation Coefficient between adjacent centres	
1	Shrewsbury		
		.303	
	Newcastle		
		.271	
	Stafford		
		.246	
	Crewe		
	- - - - - - - - -	.055	
2	Nantwich		
		.165	
	Wellington		
		.281	
	Whitchurch		
		.258	
	Market Drayton		
	- - - - - - - - -	.025	
3	Oakengates		
		.125	
	Stone		
		.393	
	Newport		
		.502	
	Shifnal		
		.499	
	Wem		
		.265	*
	Donnington		
		.569	
	Hadley		
		.720	
	Penkridge		
		.714	
	Eccleshall		
	- - - - - - - - -	.467	
4	Audley		
		.750	
	Gnosall		
		.809	
	Shavington		
		.538	*
	Bignall End		
		.565	
	Audlem		
		.780	
	Shawbury		
		.742	*
	Willaston		
		.753	
	Woore		
		.856	
	Madeley		
		.704	
	Haslington		
	- - - - - - - - -	.608	
5	Great Haywood		
		.771	
	Barlaston		
		.799	
	Hodnet		
	- - - - - - -		
	- - - - - - -		
	- - - - - - -		

Figure 6.4 The centrality values of settlements in each hierarchical group



The centrality values of each of these five groups have been averaged and plotted in Figure 6.4. The obvious inter-group contrasts are a greater number of functional types represented in the higher groups, and larger median centrality values, due both to the provision of specialised functions and a greater number of establishments in the larger centres. It is instructive to compare the results of the two methods of grouping discussed above, and to examine their relative merits. The starting point for both methods was the same, i.e. a list of 191 settlements ranked on the basis of a score derived from their total provision of retail and service functions. By the first method (and the one adopted substantively) this list wasscanned and the two settlements with the most similar scores were amalgamated into one group; the procedure was repeated until all settlements had been joined into one large group.(i) It was decided empirically that a division into eight groups, Table 6.3, was a realistic description of the differences in functional status.

The second method considered the detailed array of functions and their relative importance in each settlemant. In this way five groups were formed, Table 6.5, but with the differentiation confined to the upper end of the scale of settlement size. For this reason the second method is inappropriate to the present study. A comparison of tables 6.3 and 6.5 shows that the only discontinuity upon which the two methods are agreed is the break between Crewe and Nantwich. A more direct comparison however is afforded by arresting the progressive grouping of method 1 at cycle 185, such that it too provides five groups – Table 6.6. With this unrealistic constraint of having to produce five groups, method 1 is clearly unsuitable for it groups together all towns from Shrewsbury, an important centre for much of Shropshire and the Welsh borders, to Newport, a town of less than 5,000 people and with only local importance.

(i) In practice a variant, using log scores, was adopted.

Table 6.6 A comparison of two methods of grouping settlements

METHOD 1		METHOD 2	
1	Shrewsbury	1	Whitmore
	Newcastle		Brocton
	Stafford		Clive
	Crewe		Cotes Heath
	Nantwich		Croxton
	Wellington	2	Great Bridgeford
	Whitchurch		Prees Higher Heath
	Market Drayton		Dunston
	Oakengates		Gailey
	Stone		Albrighton
	Newport		Hales
	Shifnal		Seighford
	Wem	3	Mucklestone
	Donnington		Standon
	Hadley		Bulkeley
	Penkridge		Hopton
	Eccleshall		Baldwins Gate
	Audley		Waters Upton
	Gnossal		Spurstowe
	Shavington		Loppington
	Bignall End		Wetwood
	Audlem	4	Wybunbury
2	Shawbury		Cholmondley
	Willaston		Stowe by Chartley
	Woore		Tong Norton
	Madeley		Miles Green
	Haslington		Tern Hill
	Great Haywood		Marbury cum Quoisley
	Barlaston		Fulford
	Hodnet		Ash Magna
	Wheaton Aston		Knightley
	Betley		Gallantry Bank
	Bunbury	4	Winterley
	Prees		Rodington
	Wistaston		Norton in Hales
	Hixon		Tibberton
	Halmer End		Hadnall
	Wrenbury		Blymhill
	Ashley		Tilstock
	Loggerheads		Church Minshull
	Edgmond		Childs Ercall
	Weston-under-Lizard		Preston Weald Moors
	Hinstock		Acton
	Weston (Crewe)		Moreton Corbet
	Haughton	5	Whixall
	Weston under Trent		Burleydam
	Woodeaves		Knighton (Maer)
	Tittensor		Grinshill
3	Swynnerton		Derrington
	Wrockwardine		Stanton upon Hine Heath
	Blyth Bridge		Lilleshall
	Alsagers Bank		Yarnfield
	Worleston		Aston (Maer)
	Milford		Norbury (Staffs)
	High Ercall		Keele
	Cheswardine		Paddiley
	Bromstead Heath		Chebsey
	Sandon		Upton Magna
	Walton		Ightfield
	Alpraham		Crudgington
	Church Eaton		Hyde Lea
	Wood Lane		Bednall
	Oulton		Little Madeley
	Hilderstone		Calverhall

	Sound		Ranton
	Hatherton		Warningham
	Bradley		Great Bolas
	Cold Hatton		Hankelow
	Little Haywood		Aston
	Adderley		Preston Brockhurst
	Stoke upon Tern		Adbaston
	Ranton		Sherrifhales
	Warningham		Stretton
	Great Bolas		High Offley
	Hankelow		Stapeley
	Aston		Wardle
	Preston Brockhurst		Wistanwick
	Adbaston		Weston under Redcastle
	Sherrifhales		Acton Trussel
	Stretton		Barthomley
	High Offley		Norton Bridge
	Stapeley		Withington
	Wardle		Slindon
	Wistanwick		High Onn
	Weston under Redcastle		Tixall
	Acton Trussel		Hough
	Barthomley		Prees Green
	Norton Bridge		Balterley
	Withington		Platt Lane
	Slindon	5	Chorley
	High Onn		Great Chatwell
	Tixall		Milwich
	Hough		Bishops Offley
	Prees Green		Buerton
	Balterley		Maer
	Platt Lane		Church Aston
5	Chorley		Bradfield Green
	Great Chatwell		Admaston
	Milwich		Ellenhall
	Bishops Offley		Eyton-upon-the Weald Moors
	Buerton		Kynnersley
	Maer		Moddershall
	Church Aston		Uffington
	Bradfield Green		Whitgreave
	Admaston		Wollerton
	Ellenhall		Knighton
	Eyton-upon-the Weald Moors		Ellerdine Heath
	Kynnersley		Bunbury Heath
	Moddershall		Colwich
	Uffington		Sambrook
	Whitgreave		Fradswell
	Wollerton		Lee Brockhurst
	Knighton		Poynton Green
	Ellerdine Heath		Onneley
	Bunbury Heath		Steel Heath
	Colwich		Hanchurch
	Sambrook		Brindley
	Fradswell		Gayton
	Lee Brockhurst		Moreton Say
	Poynton Green		Chapel Chorlton
	Onneley		
	Steel Heath		
	Hanchurch		
	Brindley		
	Gayton		
	Moreton Say		
	Chapel Chorlton		

It is also evident that the two different methods of distinguishing hierarchical groups of settlements have, in this case, identified two quite different systems of groups: a choice between the two must depend upon human judgement alone.

It can be suggested that too much functional differentiation serves to confuse rather than to clarify the issue of centrality. A.E. Smailes[14] has identified trait complexes, or collections of functions which characterise towns at different levels of the hierarchy, but as one moves through the spectrum of functions towards more specialised types, it is to be expected that there will be less regularity in the occurrence of specific establishments. Difficulty will therefore be experienced in trying to establish the comparability, or relative "central" importance, of, say, a pet shop and a delicatessan, or a toy shop and a store selling only electronic equipment, and indeed the desirability of the exercise itself is brought into question.

For these reasons, therefore, and because of superior differentiation at lower levels, andgreater flexibility throughout the scale, method 1 (progressive grouping with MeasuredError Sum Squares at each stage) is here preferred for identifying the discontinuities in a ranked list of settlements. To claim that a definitivehierarchy of settlements has been established by this method would clearly be unrealistic. At best we can say that settlements in this area can be divided into groups which exhibit a hierarchical structure on the basis of their provision of service and retail facilities.

The spatial pattern of central places

One of the cornerstones upon which classical Central Place Theory rests is that each centre has its own trade area, and that these trade areas interlock and overlap in a hexagonal network — Figure 1.1. The rigid requirement of a completely homogeneous plain upon which the centres

must be located, and the perfect operation of set economic laws regarding the location of outlets and the behaviour of consumers are hypothetical conditions which do not exist. It is therefore not surprising that the existence of a hierarchical network of hexagonal trade areas can rarely be demonstrated for any area empirically studied. Skinner [15] shows that trade areas approximate to a hexagonal network in parts of China, but all too often the spacing of the settlements and centre-hinterland relationships are tacitly ignored in central place studies.

An implication of the system of hexagons is that settlements should be regularly and uniformly spaced with respect to their neighbours. Several studies have shown that even though a pattern of settlements may not fit perfectly, or even with close approximation into this framework, certain tendencies away from a purely random distribution, and towards a coherent spatial system, can be observed.

In a revealing study of the settlement pattern of certain American States L.J. King [16] applied a method of quantifying point distributions developed by the plant ecologists Clark and Evans. [17] Thus quantified, the settlement pattern could be compared with completely agglomerated, perfectly random, or uniform (hexagonal) distributions of the same density. In none of the states tested did King find a uniform distribution of central places, but he was able to arrange the states along a scale, enabling comparisons to be made between states, from Utah with the most agglomerated pattern, to Minnesota and Missouri with distributions most closely approaching uniform.

Nearest neighbour analysis is applied below, but unlike King's comparison of different areas, it has been used in this case to analyse the spacing of settlements at different orders of the supposed hierarchy [(i)] in one area. The hierarchical concept of central places

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(i) Taken here as the hierarchy described by Table 6.3.

TABLE 6.7

Grade of Settlement	No. of Settlements (i)	Density of Settlements (Sq. miles)	Mean observed distance to nearest neighbour rA	Expected mean dist. in distribution of the same density $\left(= \frac{1}{2\sqrt{P}} \right)$ rE	Nearest neighbour statistic $R = \frac{rA}{rE}$
1	4	0.0047	12.60	7.33	1.718 (ii)
2	11	0.0128	6.04	4.42	1.365
3	18	0.0209	4.81	3.46	1.390
4	34	0.0395	3.17	2.52	1.258
5	65	0.0756	2.32	1.82	1.276
6	127	0.1460	1.59	1.31	1.216
7	181	0.2100	1.34	1.09	1.227

(i) The number of settlements in each group is derived from table 6.4 by adding to the number of settlements in each group, the number in the group above it, for these supperior centres also perform as central places at the inferior level.

(ii) Although R has been calculated for grade 1 centres its usefulness is diminished by there only being four settlements in the group.

implies that each centre performs the functions peculiar to its own order, plus all those of lower orders. Thus for the purposes of this exercise, centres were plotted at each level both in their own right, and where their functional level was represented by settlements of higher orders. Straightline measures were taken between each settlement and its nearest neighbour of the same or higher status. Where a nearest neighbour lay outside of the study area, a measurement to that settlement was made, but no distance from it was measured.

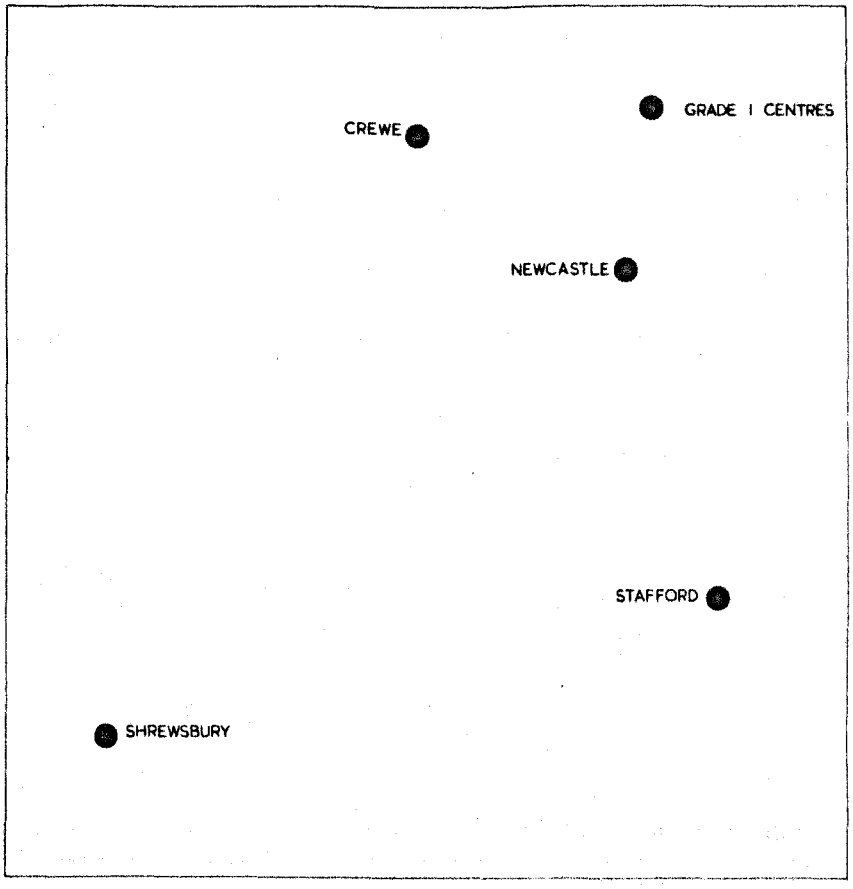
The nearest neighbour stastistic R is a comparison, or ratio between the mean observed distance to nearest neighbours in the given distribution (rA), and the expected mean distance in a random distribution (rE). Clark and Evans [18] show that the value of R varies from zero, for a completely agglomerated population, through R = 1.0 for a random distribution to a maximum value of R = 2.15 indicating a uniform (hexagonal) spacing.

Table 6.7 shows that, at each level, the observed mean distances diverge significantly from those which would be expected in a random distribution, and that in all cases the nearest neighbour statistic R indicates a pattern approaching uniform. This however is only a tendency, and in no case could the observed pattern be considered truly uniform.

The centres of each order have been mapped, and an examination of Figures 6.5 to 6.11 shows that at all but the lowest order the density of settlements is greater in the east of the area, along a broad belt from Crewe/Nantwich — Potteries — Stafford.

Correspondingly there is a relative sparsity, even of villages, in a large western area bounded by Shrewsbury, Market Drayton and

Figure 6.5 The distribution of grade 1 centres



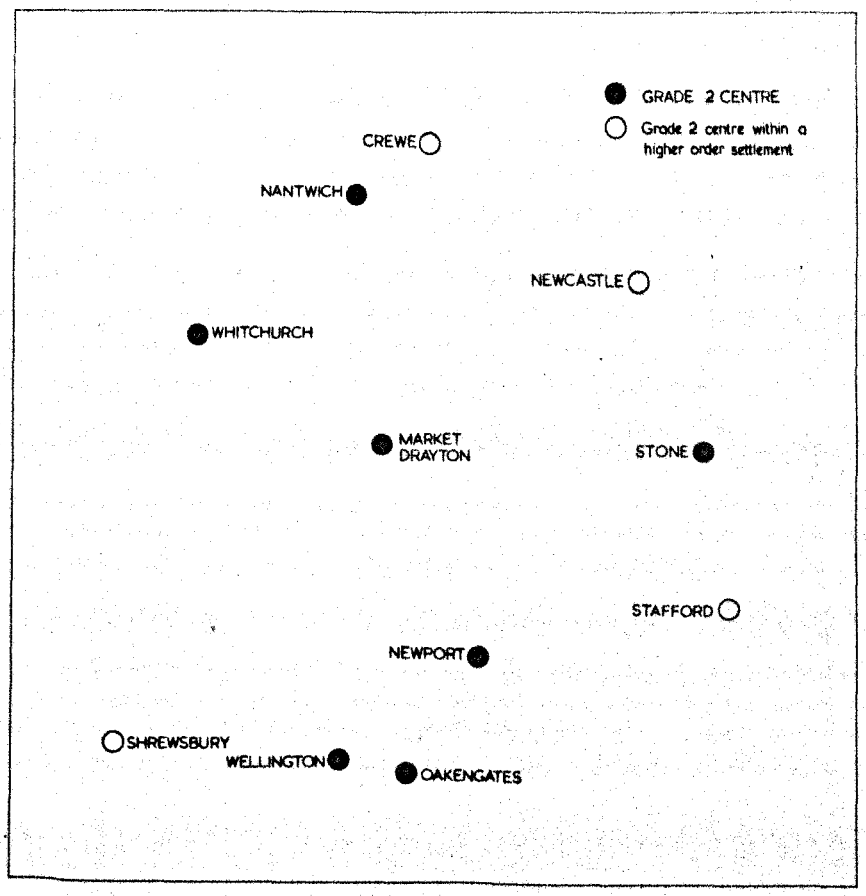
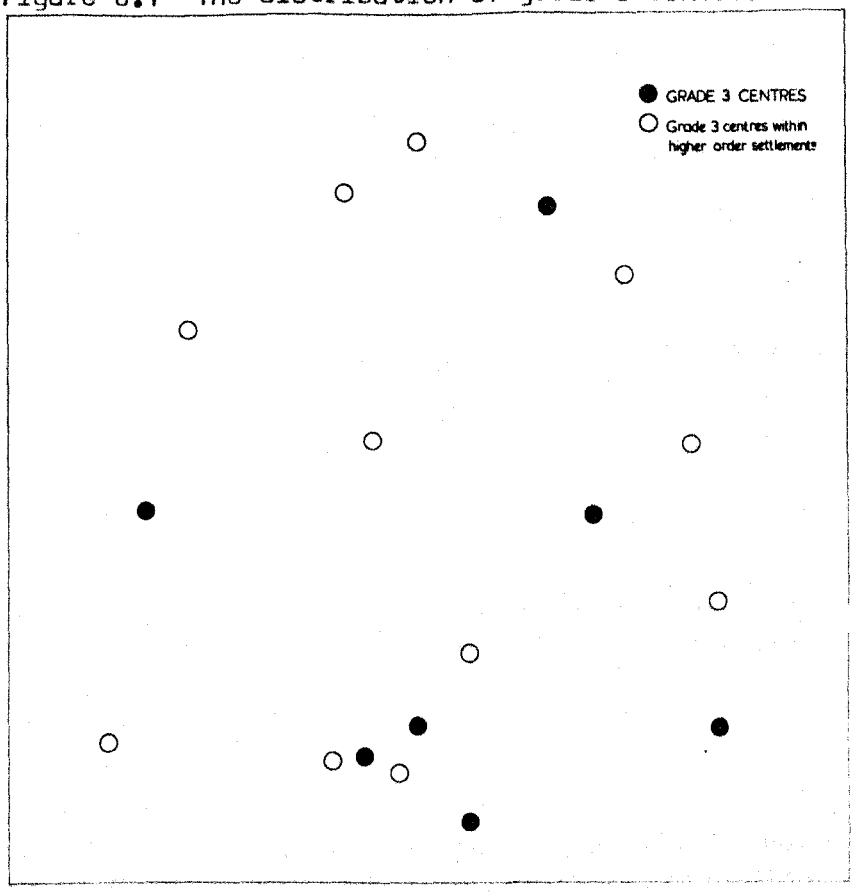


Figure 6.6 The distribution of grade 2 centres

Figure 6.7 The distribution of grade 3 centres



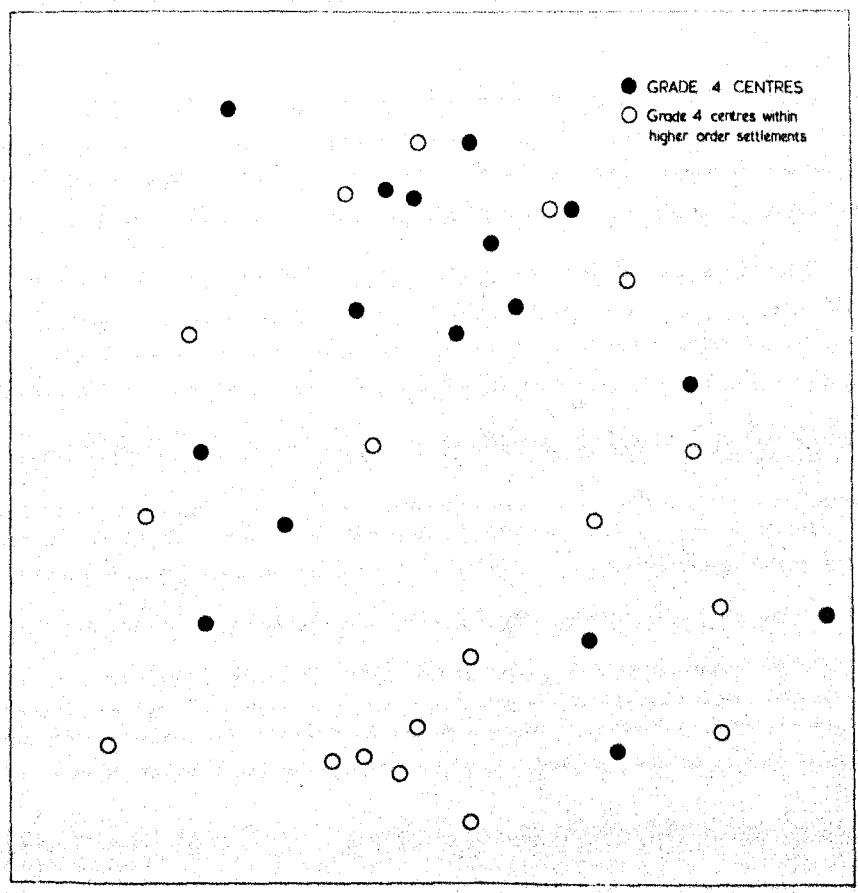
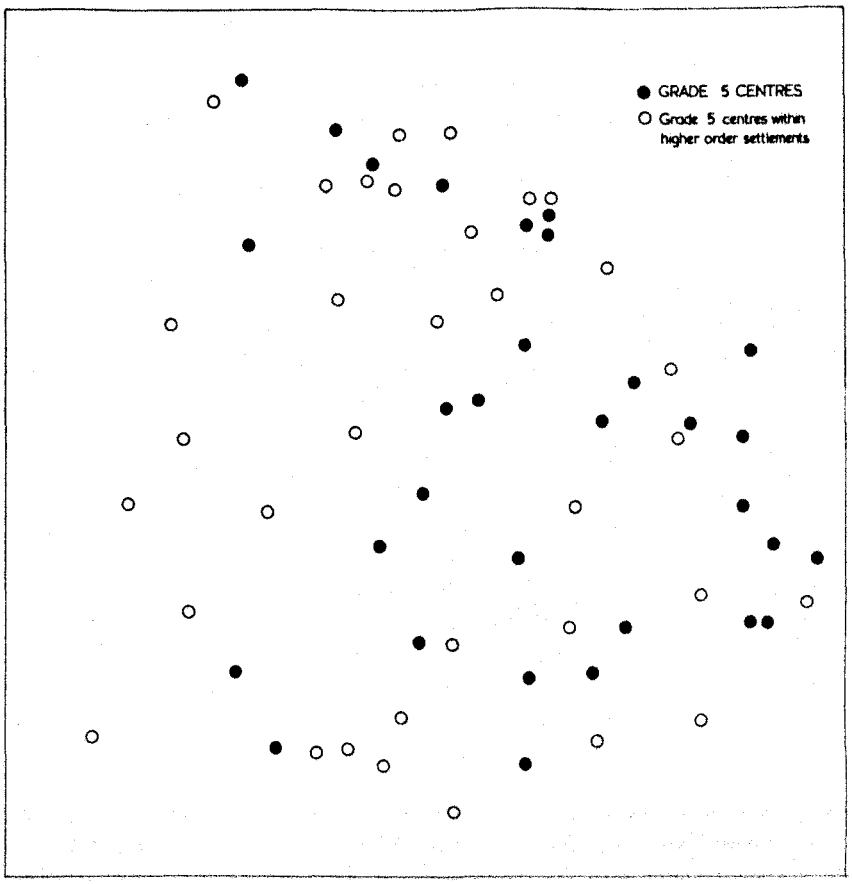


Figure 6.8 The distribution of grade 4 centres



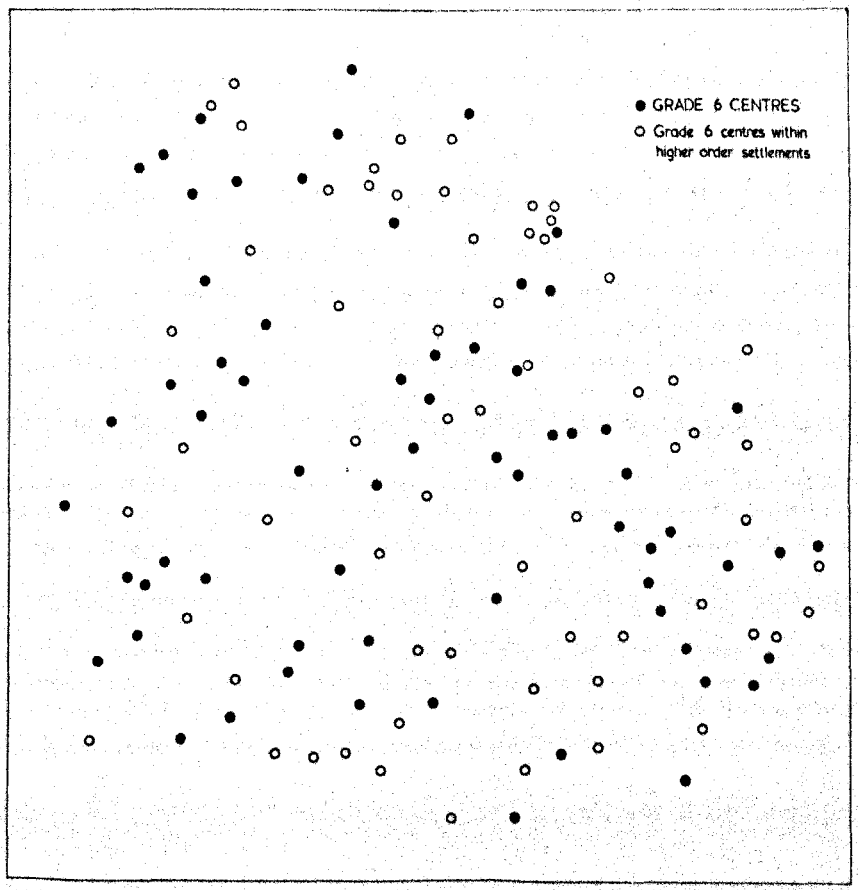


Figure 6.10 The distribution of grade 6 centres

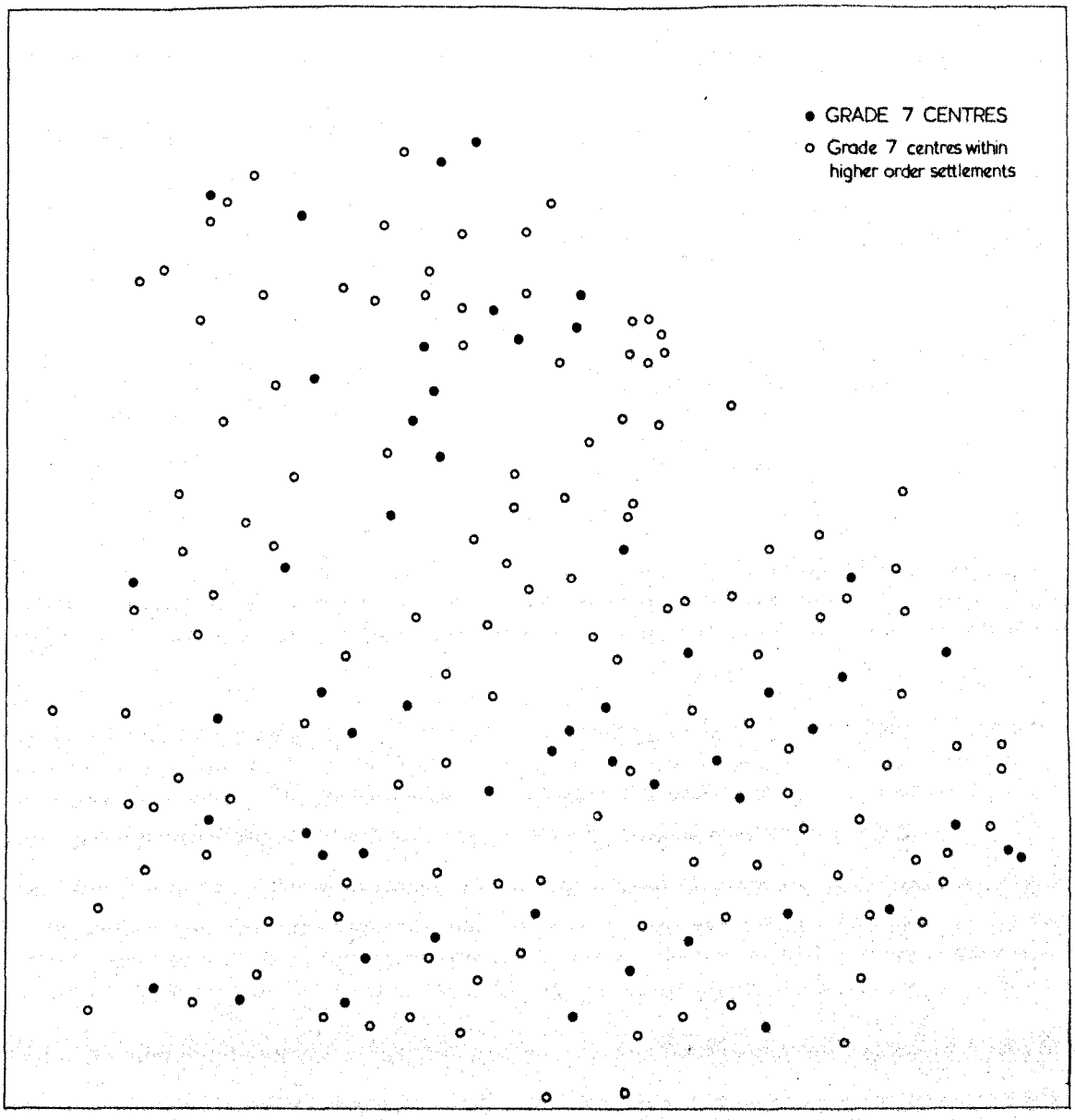


Figure 6.11 The distribution of grade 7 centres

Nantwich.

The contrast between the density of settlements of all hierarchical orders, and the complexity of the central place systems in the north and east of the area and those of the south and west, can largely be explained by the effects of industrial growth and population agglomeration in disturbing the ideal patterns which would be expected on an isotropic surface. The area is insufficiently differentiated in physical or agricultural respects (i) for this greatly to affect the settlement patterns, so we can suggest that firstly economic, and secondly planning factors are most important in determining location and patterns of present day central places at each order.

Many settlements owe their present day existence and prosperity to the employment opportunities of nearby towns and Figures 6.3, 6.5 to 6.11 reveal the way in which villages tend to cluster around the main employment centres. The effect which dormitory settlements have upon the overall pattern of settlement spacing can be further examined by a comparison of Table 6.7 with Table 6.8. For the purpose of constructing the latter, all suburban and commuter (ii) villages have been removed from consideration, and the nearest neighbour statistic R was calculated for the remaining centres. Order 1 and 2 are not affected since they do not contain any purely commuter settlements, but for the other orders the pattern of settlements, where suburban villages are excluded, approaches slightly closer to a uniform state than that for all settlements.

This alternative presented by the Table 6.8 represents largely the pattern of older settlements which would have developed originally as pure service centres on a uniform agricultural background which was more similar to Christaller's ideal state than are today's conditions.

(i) see introduction to the area in the preface.

(ii) These were identified from first hand knowledge, but in a more elaborate exercise an objective method would naturally be preferred. A list of the settlements abstracted at each order is appended to Table 6.8

Table 6.8 The Nearest Neighbour Statistic (Excluding Suburban Settlements)

Grade of Settlements	No. of Settlements	Density of Settlements per sq.ml.	Mean observed dist. to nrst. neighbour rA	Expected mean dist.in random distribution of same density rE	Nearest neighbour statistic R
1	4	0.0047	12.60	7.33	1.718
2	11	0.0128	6.04	4.42	1.365
3*	16	0.0186	5.40	3.68	1.469
4**	25	0.0291	3.97	2.93	1.353
5***	47	0.0546	2.804	2.14	1.309
6****	101	0.1170	1.839	1.459	1.260
7*****	151	0.176	1.482	1.192	1.243

* Excluding Donnington and Hadley

** Excluding above plus Willaston, Haslington, Bignall End, Barlaston, Wheaton Aston, Shavington and Great Haywood

*** Excluding above plus Wistaston, Halmer End, Loggerheads, Edgmond, Alsagers Bank, Haughton, Walton, Milford, Blythe Bridge

**** Excluding above plus Seighford, Hopton, Miles Green, Brocton, Acton, Derrington, Wybunbury, Hyde Lea

***** Excluding above plus Church Aston, Colwich, Stapeley and Warmingham

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Conclusion to Section I

Several alternative methods for measuring the centrality of settlements have been outlined, although in this first section of the study all these have depended upon an analysis and assessment of the functions represented in different centres. Most previous studies have concentrated upon measuring rank in relation to retail facilities, but in the foregoing discussion it is suggested that both the services and social opportunities provided by a settlement are equally important factors in centrality. This is especially true at the lower end of the scale of settlement size. Other functions have been introduced as measures of centrality, e.g. employment, but these seem to be less crucial indicators and pose severe problems of measurement and comparability. Their usefulness in this context is therefore limited.

The methods outlined fall into two main groups. The first involves an overall assessment of the total functional equipment in each centre, together with a subsequent detailed analysis. The second relates the number of functions possessed by a centre to other measures of settlement size, such as population, in an attempt to distinguish centres which have functions surplus to their own requirements.

As might be expected different measures of centrality give different rankings to the settlements and suggest contrasted hierarchical groups. In part, these varying results reflect the contrasting definitions of "centrality", and the various techniques illustrate that there are many aspects of the concept. In short no absolute statement of the urban hierarchy emerges; there are almost as many hierarchies as there are technical approaches.

The settlements in the area range from large towns, such as Newcastle-under-Lyme and Shrewsbury, down to a multitude of small villages. Comparisons between the possible ways in which these settlements may be classified, or grouped into a hierarchy are explored.

Though some settlements are consistently ranked high and others low, many settlements move up or down the hierarchy or orders depending upon the techniques applied. For example, techniques for establishing centrality on the basis of a total functional count, and those based upon a functional surplus/deficit are quite dissimilar, and close comparisons should not be sought amongst the results.

The choice of techniques for determining centrality, and for establishing hierarchical groups depends upon the final use to which the results are to be put, and the time and resources available. Greater depth of analysis and improved accuracy can be achieved by the most detailed and consequently laborious investigations. A rapid scheme for ranking settlements is the rudimentary Index of Retail Centrality (Table 4.1), but this is intended purely as a simple guide, and only a more sophisticated approach will combine accuracy with consistency.

The preferred solution here is to rank settlements by their overall functional scores, and to identify orders of centres by progressive grouping with a measured "Error Sum of Squares" at each stage. The advantages of this method have been argued in previous pages, but briefly they are as follows:-

(1) The total functional score based upon location coefficients, largely eliminates the problem of comparing un-like functions.

(2) The flexibility of the scheme allows either a complete or a selective range of functions to be considered.

(3) Settlements of widely dissimilar size can be ranked and grouped in one list.

(4) It is an objective and quantified grouping procedure which produces alternative statements of the hierarchy with a measured loss of detail in each case.

This section (chapters 3 - 6) has been concerned with several alternative approaches to the measurement of urban centrality, and the

question of ranking settlements into a functional hierarchy. Although different techniques have been explored, they all involve an assessment of the number of functions possessed by centres, and the mixture of such functions within settlements, or the measurement of functions against other variables such as population. As such these studies focus upon the settlements themselves and take no account of the reciprocal relationships between centres and their service areas. The town-hinterland relationship is an essential and inherent part of the concept of centrality, and it is towards this question that our attention will be turned in the section which follows.

Chapter 7 - The identification of nodal systems and an examination of rural-urban linkages.

The first part of this thesis has been concerned with an analysis of the functional status of central places: it has been implicit that these settlements gain their centrality by performing services and providing goods for the population of a surrounding area, but so far we have made no attempt to measure the way in which these centres are in fact used. The next three chapters examine the way in which rural people use central places at various hierarchical orders, and the consequent rural-urban interactions which develop as part of the pattern of retail and service provision. In brief it is proposed to examine the "use-characteristics" of settlements in order to evaluate both their centrality and the pattern of hinterlands which they develop.

The linkages between rural consumers and their service centres constitute the backbone of central place study, or as Davies [1] suggests "an understanding of the dynamics of the functional and spatial relationships between towns, and between towns and their service hinterlands, is one of the main goals towards which research in the field is directed".

In the absence of any published information on the shopping patterns and urban linkages established by rural people a questionnaire survey (i) was devised for the collection of data. The main aim of this survey was to establish the centres from which a random sample of people obtained a selective list of goods and services, (ii) and to discover how many visits they had made to different urban centres during a four-week period. From this information, and knowing the place of residence of each respondent a pattern of shopping movements, with the emphasis on

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(i) This is more fully explained in Appendix E,

(ii) In order to simplify the questionnaire, and thus encourage a high response rate, only nine goods and services, believed to be typical and representative, were included. These were:- Bank, Grocer, Butcher, Post Office, Chemist, Electrical goods, major items of clothing, Doctor, Dentist.

direction, distance and frequency of visits could be constructed. After preliminary surveys to test alternative approaches a postal questionnaire was sent to 2½ percent of households living in rural districts within the study area. The rating and valuation lists of local authorities formed an up to date and complete sample frame, and nearly 59 percent of the questionnaires despatched were returned, an unusually high return for a postal survey.

Nodal systems

An initial expression of the nodal structure of the study area can be gained by establishing which towns have been visited by rural consumers for shopping purposes in the month prior to the survey. A simple line representing a linkage of this nature between an individual consumer and an individual town is of limited value. Thus in order to provide more meaningful detail about the importance of these linkages, the way in which localities, rather than individuals, are linked to the major nodes within the central place system has been examined. In particular it is valuable to measure the relative sizes and strengths of the linkages that have evolved, and also to show connections with centres other than the dominant one. Individual replies to the questionnaire have therefore been aggregated into parish totals, or where parishes are large, into groups of five respondents. This enables us to go beyond the simple statement that an individual consumer had used a particular centre during the month of the survey, and we can now suggest what percentage of shopping visits from each parish are made to each town.

Figure 7.2 (i) has been compiled in this way from answers to the

(i) For the sake of clarity the names of centres have been omitted from this series of maps, they are however shown on the location map Figure 7.1.

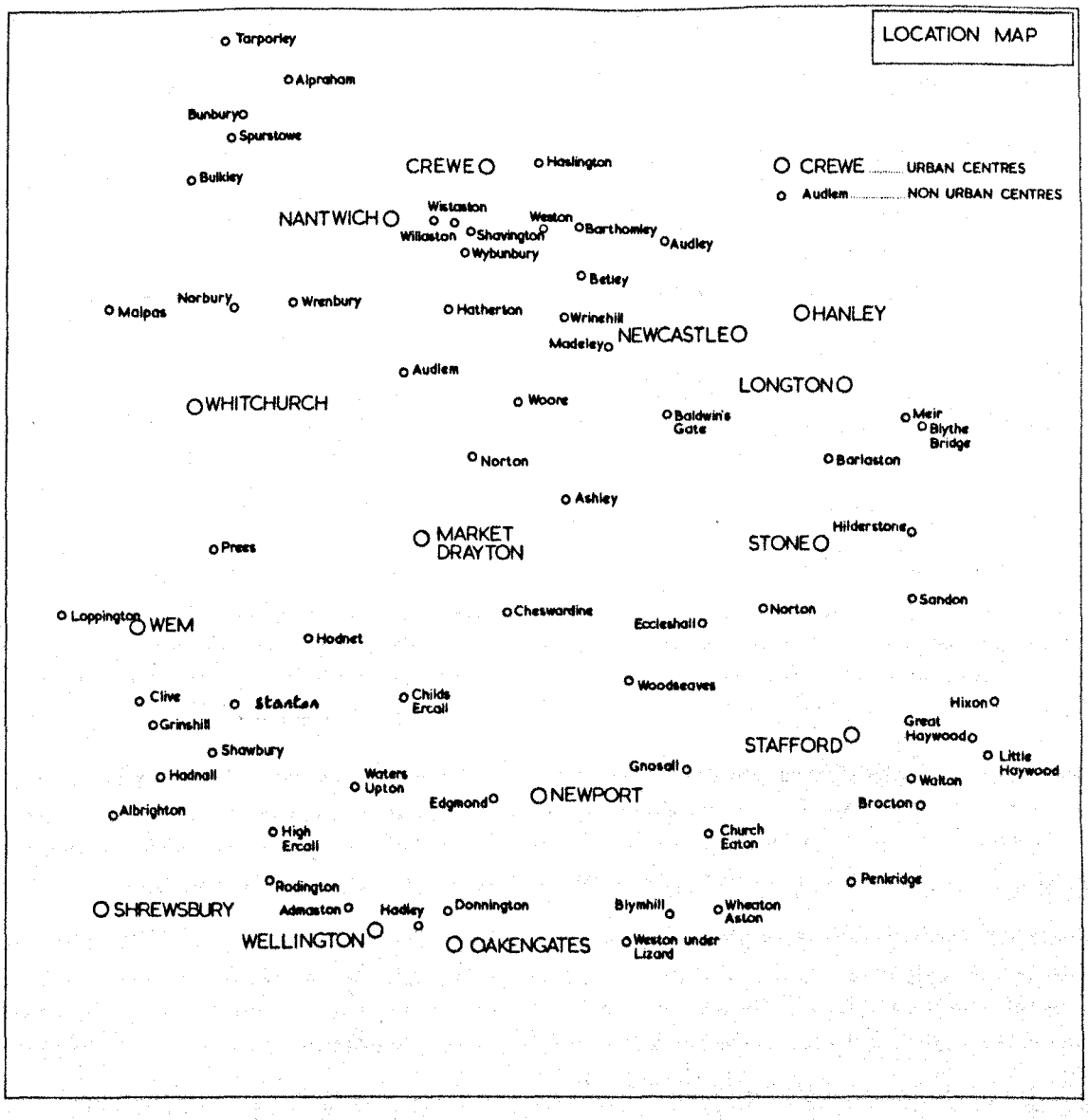


Figure 7.1 The location of centres shown in Figures 7.2 - 7.8

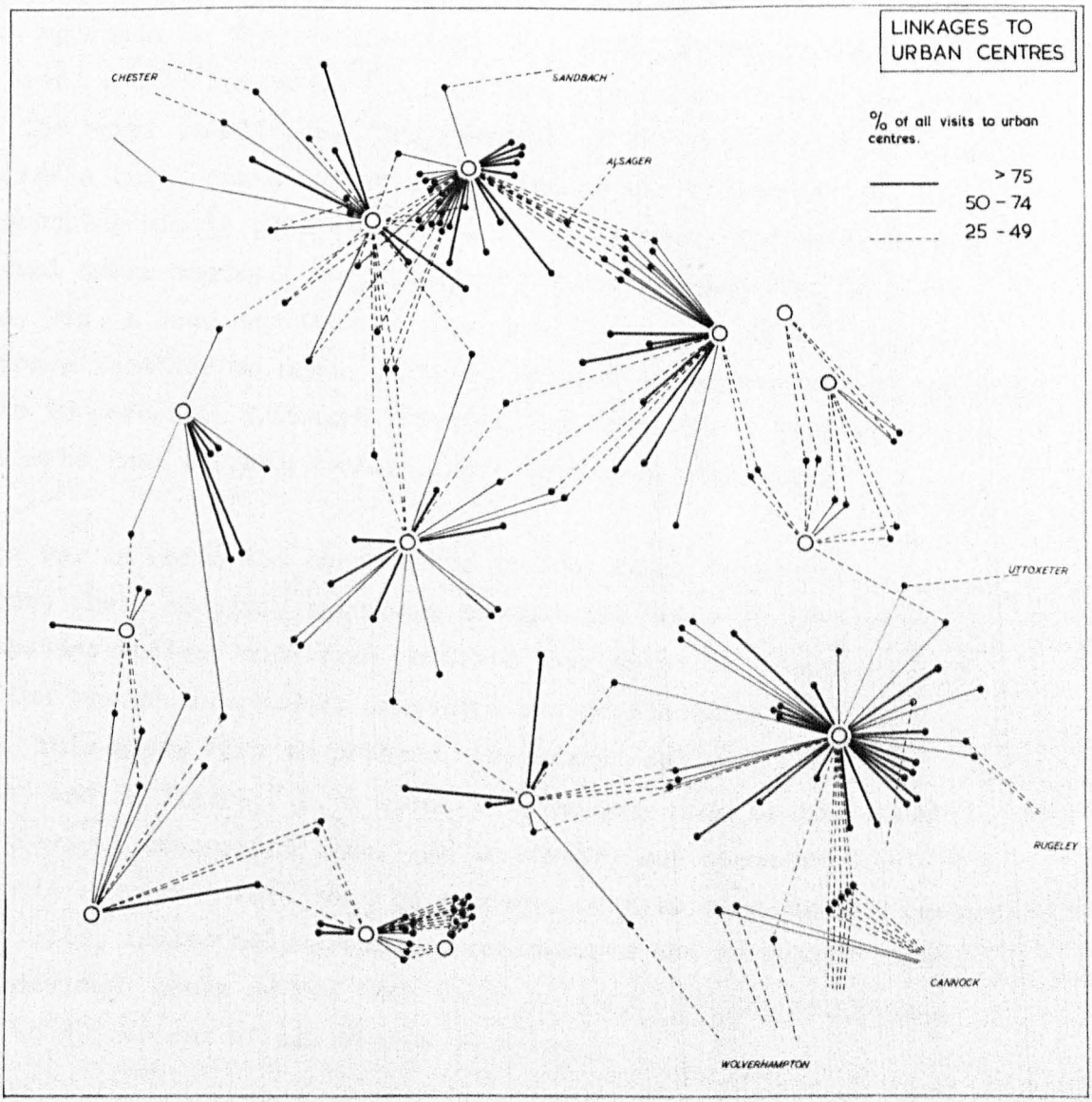


Figure 7.2 Rural linkages with urban centres; percentage of visits

question "which towns have you visited for shopping purposes in the last four weeks, and how many visits have you made to each?". It is a first approach to the establishment of a nodal structure for the study area, and it indicates the relative importance of each town for all of the rural localities. The strength of the interaction between a town and a rural community is quantified by the proportion of all urban shopping visits from each rural locality which are made to each individual urban centre; for simplicity these are depicted by three classes, viz, a town may attract more than 75 percent of all visits made from a locality to urban centres, between 50 percent and 74 percent, or 25 to 49 percent. Linkages representing less than a quarter of all urban visits from a rural locality have here been neglected.

The way in which the respondents in individual localities distribute their shopping patronage amongst the towns in the central place systems varies, thus some parishes have established significant links with two or more towns, or others are dominated by a single centre. This gives rise to primary, secondary, and even tertiary linkages, and in Figure 7.2. a locality's primary node is indicated by its heaviest connecting line. It is however not necessary that this line should represent more than 75 percent, or even more than 50 percent of all visits, indeed many groups of respondents are so weakly linked to an individual urban centre that their primary linkages represent only 25 to 49 percent of all visits to towns.

The centres identified by Figure 7.2 are all urban nodes, and it is evident that some have stronger, and more extensive links with their surrounding rural districts than others. The four largest towns of Crewe, Newcastle, Stafford and Shrewsbury are well developed nodes, as are the larger of the market towns. The small towns of Stone and Oakengates however are overshadowed by superior centres and are seen to

be weakly developed nodal points.

The value of establishing such a nodal structure depends entirely upon accurate measurement of the links that exist between town and country, and clearly these may be quantified in different ways. It has been seen above that the linkage system may be measured in terms of proportions of the total number of townward trips originating in each discrete locality which are directed to particular centres.

The strength of the linkages may also be expressed in terms of the frequency of trips made (on average) to each town by residents in each rural locality with which a link may be identified, Figure 7.3, and a frequency of visiting value can be determined. Figure 7.3 indicates a more complex system than the previous one because towns act, weakly as nodes even though they may claim only a very small percentage of the total trips undertaken by any localised group of consumers. In order to simplify the pattern, Figure 7.3. indicates only the links to the two centres most frequently used by respondents in each locality. (i)

Three broad conclusions are possible from these two maps :-

(1) the strongest linkages, represented both by a high frequency and large proportion of visits are confined to respondents' nearest towns without reference to the hierarchical order of those towns;

(2) secondary linkages are invariably to towns of higher order than the dominant node, and in many cases are represented by a frequency of visiting of less than once a month;

(3) the frequency of visits to towns also reflects the local retail-service provision in the rural area. Where there is a good range of shops providing the more commonly required goods locally (e.g. Penkridge, Donnington, Willaston) the frequency of visits to town is low.

(i) In some cases only a single town was reported to have been visited in the month prior to the survey.

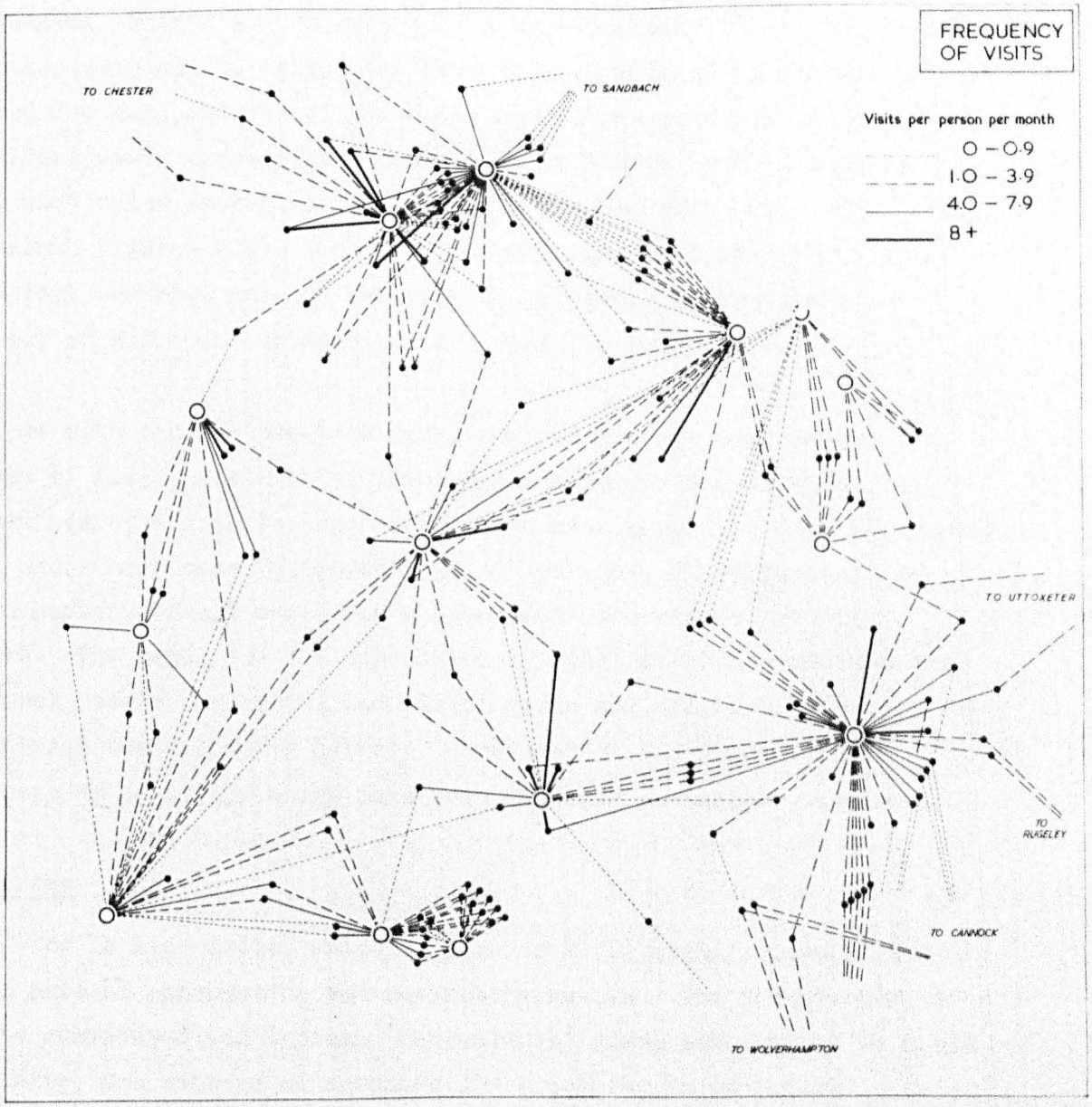


Figure 7.3 Rural linkages with urban centres; frequency of visits

Recognising that not all shopping trips are similar, the visits to towns have been sub-divided and mapped according to the goods purchased. Within the framework of a questionnaire it was not possible, or even desirable to calculate the frequency with which centres were visited for each individual purchase, but it was possible to compute the linkages in terms of the proportion of visits from each parish to a particular centre for individual goods and services. The resulting patterns, Figures 7.4 - 7.8 are a comment upon both the status of different centres, and the behavioural movements of consumers in respect of different categories of demand for urban services.

As with the two previous maps, respondents are aggregated into groups of five. For each of five types of goods and services the percentage of visits to each centre have been mapped in four categories, viz, where more than 75 percent, 50 -74 percent, 25-49 percent, and 15-24 percent of all trips for a specified good are to the single centre. The maps, and the discussion of nodal structure established by rural people purchasing individual goods and services, which follows, illustrate the dichotomy between 'convenience' and 'competitive' patterns of shopping behaviour which have been outlined in earlier chapters.

Groceries

Food is a commodity which is purchased frequently because of its rapid rate of consumption and perishable nature. For this reason it can be considered the typical 'convenience' good, although as we shall see later, the pattern of shopping for groceries is one which is undergoing important changes.

At this level of demand more centres are identified as nodes than for any other good, and this is consistent with the existence of food

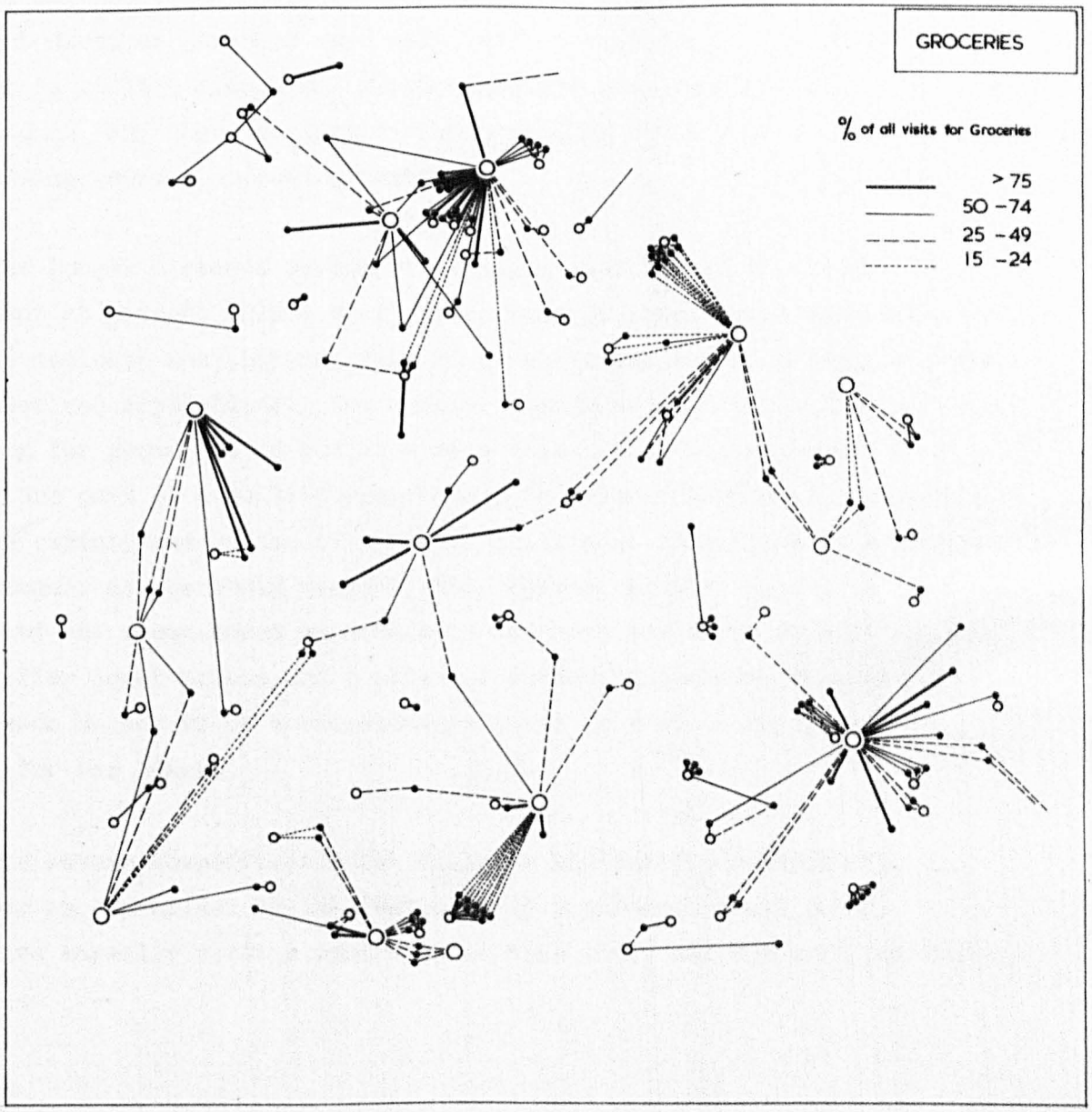


Figure 7.4 Linkages for grocery shopping

stores at even the lowest order of the central place system. The overall pattern of movement which emerges in Figure 7.4 is dominated by short distance journeys to a multitude of centres. The basic pattern is still a simple one which expresses the principle of convenience, and there is little indication of rivalry or a division of spending between competing centres.

The longer distance secondary linkages depicted in Figure 7.4 represent at present only a small proportion of total trips made, but they do indicate the changing role of larger towns in providing groceries to hinterland populations. The simple "convenience' pattern of shopping for groceries is modified by a competitive element where food items form part of a multi-purpose trip to a large town which provides greater variety and choice of goods of all kinds. Additionally a proportion of consumers deliberately neglect their nearest grocery outlet in favour of the urban-based supermarkets and cash and carry establishments which offer lower prices and a range of marketing bonuses. This process is perhaps selective by socio-economic class in that it has great appeal for car owners.

The severe competition which villages and small centres suffer in this way is emphasised by the fact that 45.9 percent of all rural consumers normally visit a centre other than their nearest when purchasing groceries.

Doctors

Doctors (together with banks) were included in order to enable an analysis to be made of movement patterns in relation to non-retail functions. Like grocers they generate a simple, short range, non-competitive pattern of movement of 'convenience type,' Figure 7.5. Several of the large towns, e.g. Shrewsbury, Hanley, are not mentioned or show up very weakly, whereas small towns (e.g. Whitchurch, Market Drayton) and a number of villages are identified as strong nodes.

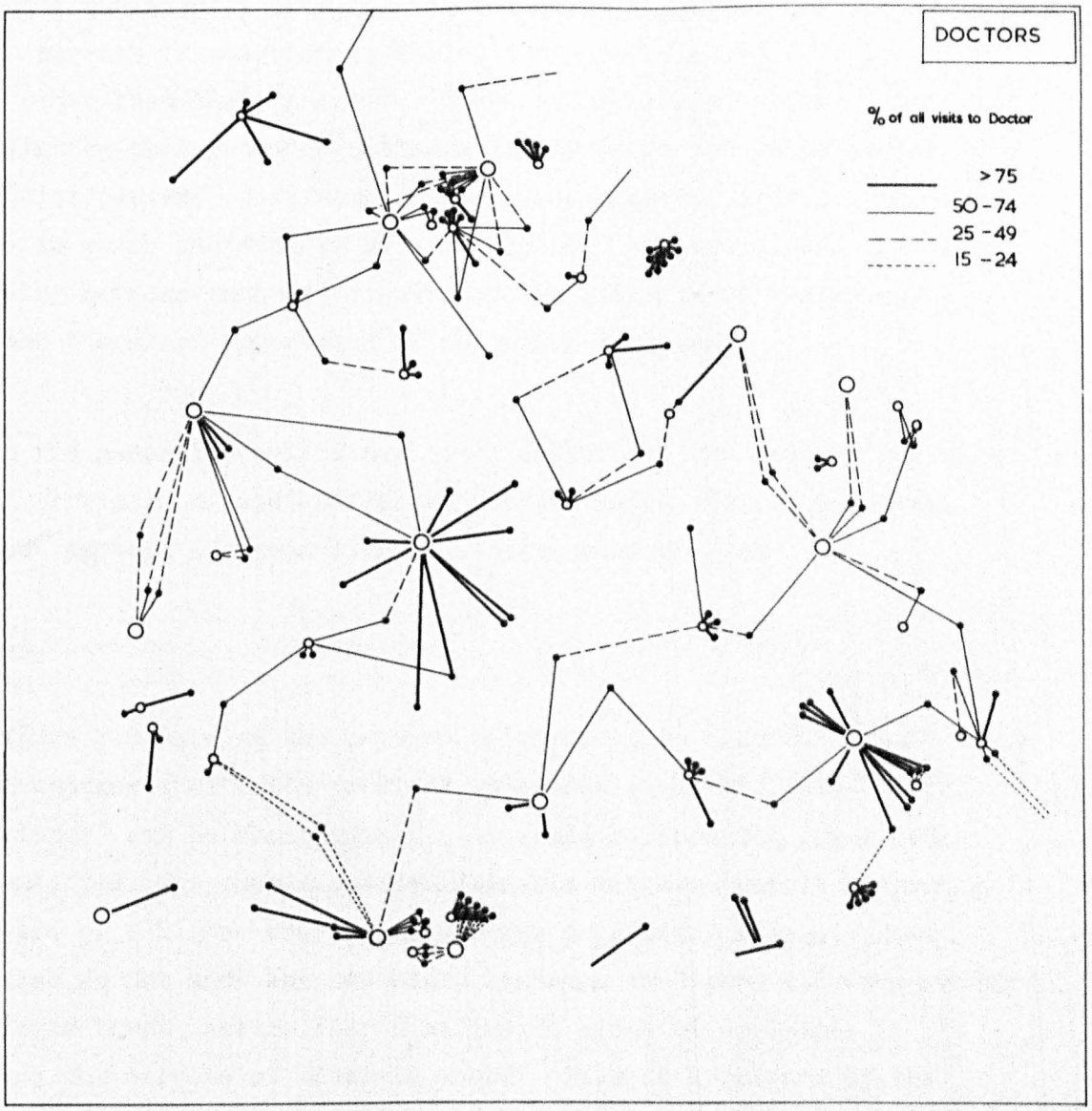


Figure 7.5 Linkages for visits to the doctor

The relatively large number of nodes and the short-range of the movement lines signify patronage of the nearest doctor, and indeed only 19 percent of respondents stated that they visited a doctor in a centre other than their nearest. There is of course an artificial constraint on this pattern in that a doctor could refuse to accept a potential patient if it would involve unecessarily long journeys. The way in which centres are able to dominate sub-areas, and the lack of rivalry between centres is shown by the strength of the movement lines and the minor importance of secondary linkages.(i)

At the general practitioner level therefore, the fact of registration and the provision of a standardised service means that a relatively clear cut pattern of domination by single nodes emerges.

Chemists

Figure 7.6 showing the pattern of movement to chemists shops offers several contrasts with the previous maps, but again the principle of 'convenience' can be demonstrated. As would be expected fewer nodes are identified, for chemists establishments are more rarely occurring and so are of a higher order than doctors or grocery stores. Most localities do not show any secondary linkages in Figure 7.6, suggesting that single towns assume fairly exclusive areas of dominance in providing the service of chemists shops. This is supported by the small proportion (18.7 percent) of consumers who visit centres other than their nearest one. Chemists are the lowest order shops to have an almost exclusively urban or large village location, and it can be seen, given variations in hinterland population, that the small towns and large villages are as strongly represented as the larger centres.

(i) Despite the exclusive nature of registration with a single doctor. secondary linkages are of course possible among sample groups of five respondents.

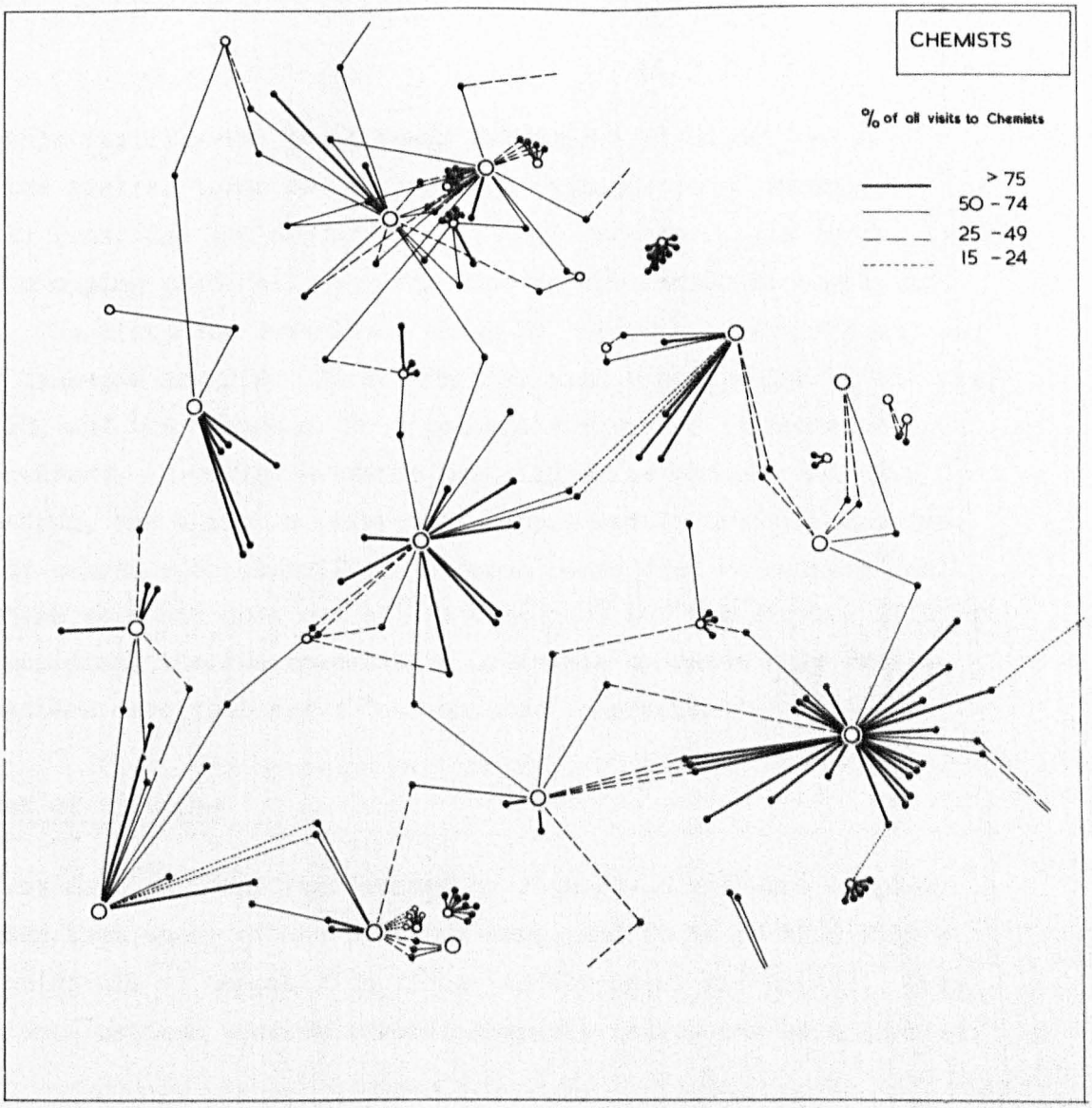


Figure 7.6 Linkages for chemist's goods

In particular the centrality of the larger villages (e.g. Penkridge, Eccleshall, Audley and Audlem) at this level should be noted.

Banks.

For this facility the large towns are important nodes, but so also are the smaller towns and a few large villages (e.g. Shawbury, Eccleshall, Penkridge and Bunbury). Although banking habits may be closely allied to shopping patterns, they may also be determined by employment location. The distances travelled, shown by Figure 7.7, are modest, and secondary linkages are few. This, together with the strength of the ties illustrated, and the figure of 24.7 percent for visits to banks other than the nearest, provides evidence that individual nodes dominate their own area, and again a relatively simple nodal structure emerges. There is of course some competition between banks (and so between small centres where each has only one or two branches) but the service offered is so standardised that the competitive principle operates only feebly, and the pattern developed has a 'convenience' character.

Major items of clothing

The movement patterns represented by Figure 7.8 are more complex and confused than those of the previous maps, and it is on this Figure that the principle of competition finds its strongest expression. From this intricate pattern however several characteristics can be distilled.

More towns outside of the area have been nominated as centres in which respondents buy major items of clothing than for any other purpose or need. Those named most consistently are Chester and Manchester in the north, and Birmingham and Wolverhampton to the south. Although the smaller towns of the study area appear to have some centrality at this level, the five centres which dominate are all large towns viz, Crewe, Newcastle, Hanley, Stafford and Shrewsbury. Some of the smaller towns

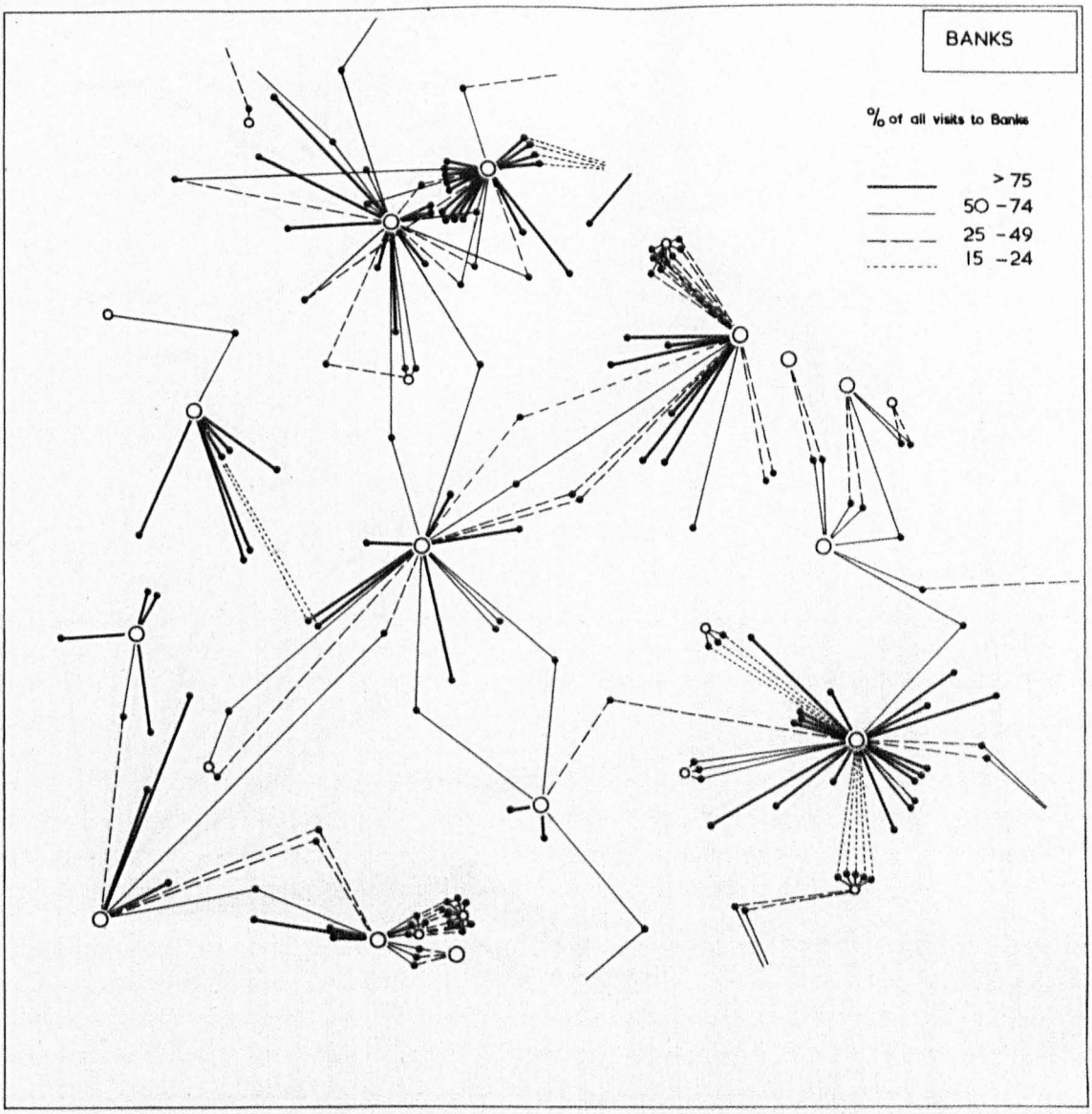


Figure 7.7 Linkages for visits to the bank

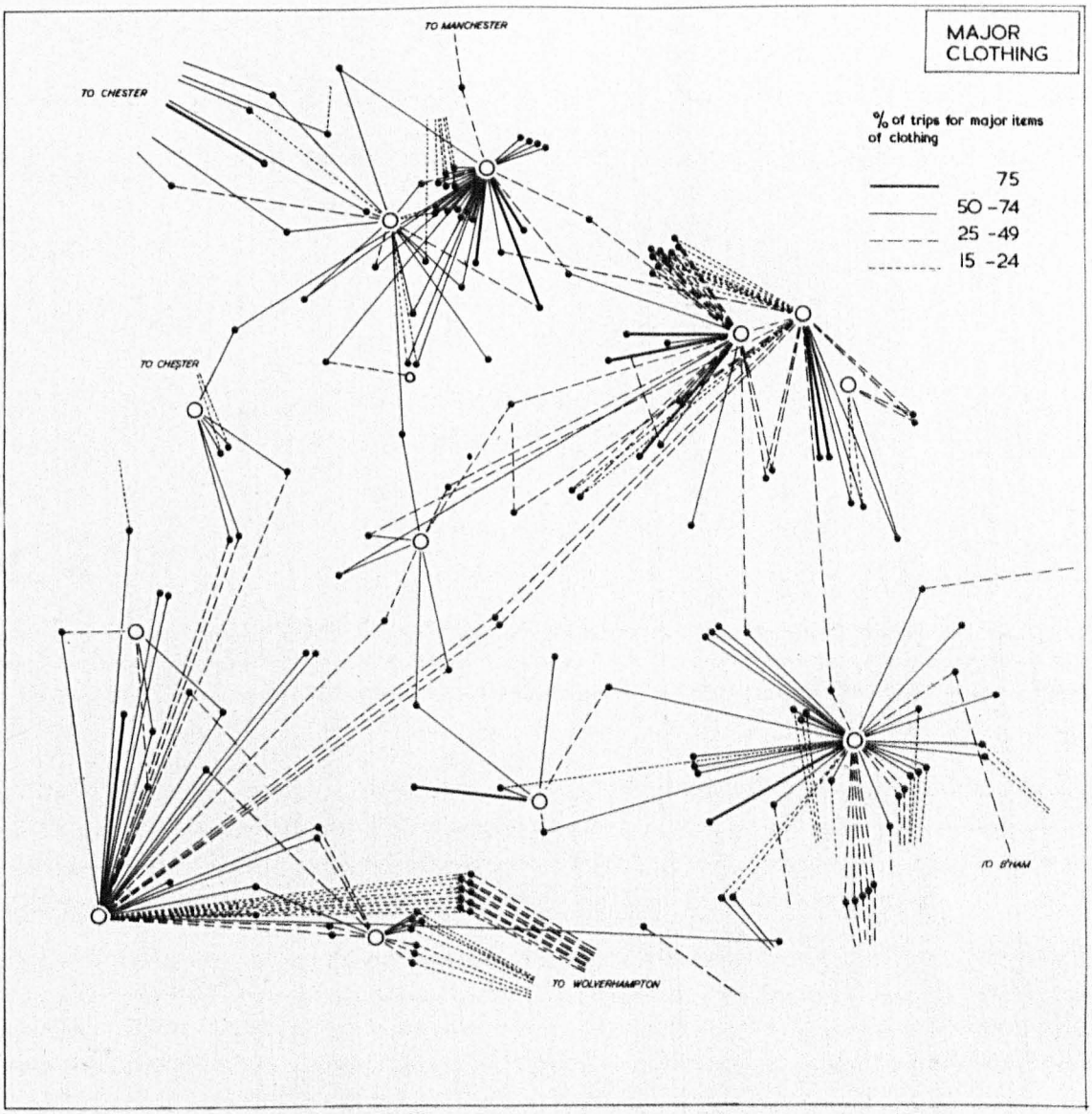


Figure 7.8 Linkages for major clothes shopping

such as Cakengates and Stone which suffer great competition from nearby, superior centres, do not emerge as nodes for major items of clothing.

In Figure 7.8 the lines indicating movement of rural consumers to shopping centres are longer than in any other map of this series; this suggests that for major items of clothing people are prepared to travel further than for all other goods. The paucity of heavy lines, and the abundance of secondary linkages indicates the important element of choice, and of comparison and competition in shopping for clothes. Again this is substantiated by the high proportion (47.6 percent) who normally visited centres other than their nearest clothing outlets. Many respondents in fact listed as many as five or six alternative centres, but linkages were only plotted where they represented at least 15 percent of the journeys made by any group of respondents.

Newcastle and Hanley, only three miles apart, were found to be used as complementary centres; only if their requirements could not be met in Newcastle would many consumers go to the larger centre. Only Audlem emerged as a non-urban node for major items of clothing, but with only one clothing store, and only one parish nominating it as a centre, its importance is clearly limited.

These maps (Figure 7.2 - 7.8) present a series of extracts of the overall nodal structure of the study area, and they also indicate some of the characteristics of the trading hinterlands of the various centres for different types of goods and services. There are a number of general conclusions to be drawn, but first we should qualify our discussion by noting that the patterns established by the maps represent only a partial view of the total linkage system of the area. In particular a general linkage structure would also be required to recognise such movements as the journey to work and trips for social purposes.

By considering the aggregated movements from parishes, or smaller than parish population groups, rather than individual movements, some degree of areal accuracy is sacrificed. This however is justified by the greater ability to assess the relative importance of linkage in terms of the frequency of trips, or as the proportion of trips which originate in a particular sub-area and terminates at a specified centre.

The patterns identified can be arranged along a scale which represents the distinction between the simplicity of a 'convenience' pattern and the complexity of a 'competitive' one. The most straight forward pattern of linkages is that for doctors, but its simplicity is only partially due to the large number of nodes and the predominance of short journeys. An Equally important factor is the high proportion of single linkages each of great strength (represented by the thickest lines in Figure 7.5) for this indicates that most parishes or sub-areas are dominated by a single centre for visits to the doctor. A similar characteristic, but in lesser degree is shown by groceries. Banks and chemists generate longer range trips but still with relatively little complexity arising from the competitive and comparative principles in shopping. It is among the complex, long range movements of journeys to shop for major items of clothing that the competitive principle is best shown.

The strength of the linkages measured as a percentage of all the urban trips from a given area which terminate at an individual centre, identifies the importance in many sectors of demand, of the small market towns and large central villages. Each centre varies in its relationship with its surrounding area, but some evidently have geographical advantages. Wellington and Nantwich gain from the pseudo-rural populations of such settlements as Donnington, Hadley, Willaston and Wistaston, and Market Drayton has an advantage in its isolated location.

The linkage patterns illustrated also clarify the way in which

individual nodes influence their trading hinterlands. At the lower levels of demand, e.g. for a doctor's services, this influence amounts to a relatively simple patterns of dominance. At higher levels of demand however, e.g. for major items of clothing, this dominance does not occur and a more complex nodal structure emerges. The greater average length of journeys, and the preponderance of secondary linkages is evidence that at this level rural areas are affected by the competing influence of several towns, and are rarely dominated by a single centre.

Consumer behaviour and the range of a good.

Implicit in the foregoing arguement has been the concept of the range of a good, of which Berry [2] says "---- the minimum size of market area required for support of successively lower-order goods will be progressively less than the hexagons for the highest order good". This is illustrated by Figures 7.2 - 7.8 which show how the villages and small towns only attract consumers from modest distances, or ranges. In short they have a small economic reach. This inability of villages and small towns to attract trade from a great distance is due in part to their limited provision of goods and services; in particular they lack the higher order goods such as furniture and major clothing outlets for which consumers are prepared to travel considerable distances in order to maximise their choice and selection. If a village possesses a single outlet for a particular durable good, this will not necessarily attract consumers from any great distance for it will be in direct competition with larger centres offering a wider choice.

In addition to the variations in range for individual goods there can be a substantial difference between the 'ranges' of establishments of broadly similar functional type. The village and small town establishments of any functional type differ from their large town

counterparts, and therefore they set up different hinterland patterns. This is largely explained by the enigmatic factor of quality, a small village chemist for example is far removed from a main branch of "Boots", so the suggestion that different goods have different ranges and threshold requirements must also be seen in the context that different centres serve different levels of demand. Thus the trade areas established by settlements lower down in the hierarchy are limited not only by the variety of goods and services which they can offer, but also by the level of quality and sophistication at which that provision is made.

The range of a good is of course also closely allied to the frequency of occurrence, and so to the distribution of outlets for that good. Thus the empirical assessment of the range of any good or service will depend upon the number of centres from which it can be provided, i.e. consumer travel distances will in each case be determined by the number of nearby centres which provide the good in question.

One of the difficulties in reconciling theory and reality in regard to the range of a good is that the multi-purpose shopping journey blurs the distinction between separate goods, and in practise the real range of penetration of the hinterland is proved, empirically, to be much the same for what should in theory be low-range goods as it is for high-range goods.

The discussion here is centred upon specified functional types of establishments, e.g. Chemists, grocers, rather than upon more narrowly defined individual goods, e.g. toothpaste, breakfast cereal, but within this limitation we can suggest that two factors determine the economic reach, or range of each functional type. The first factor is the nature of the function itself, and Figures 7.4 - 7.8. showed how

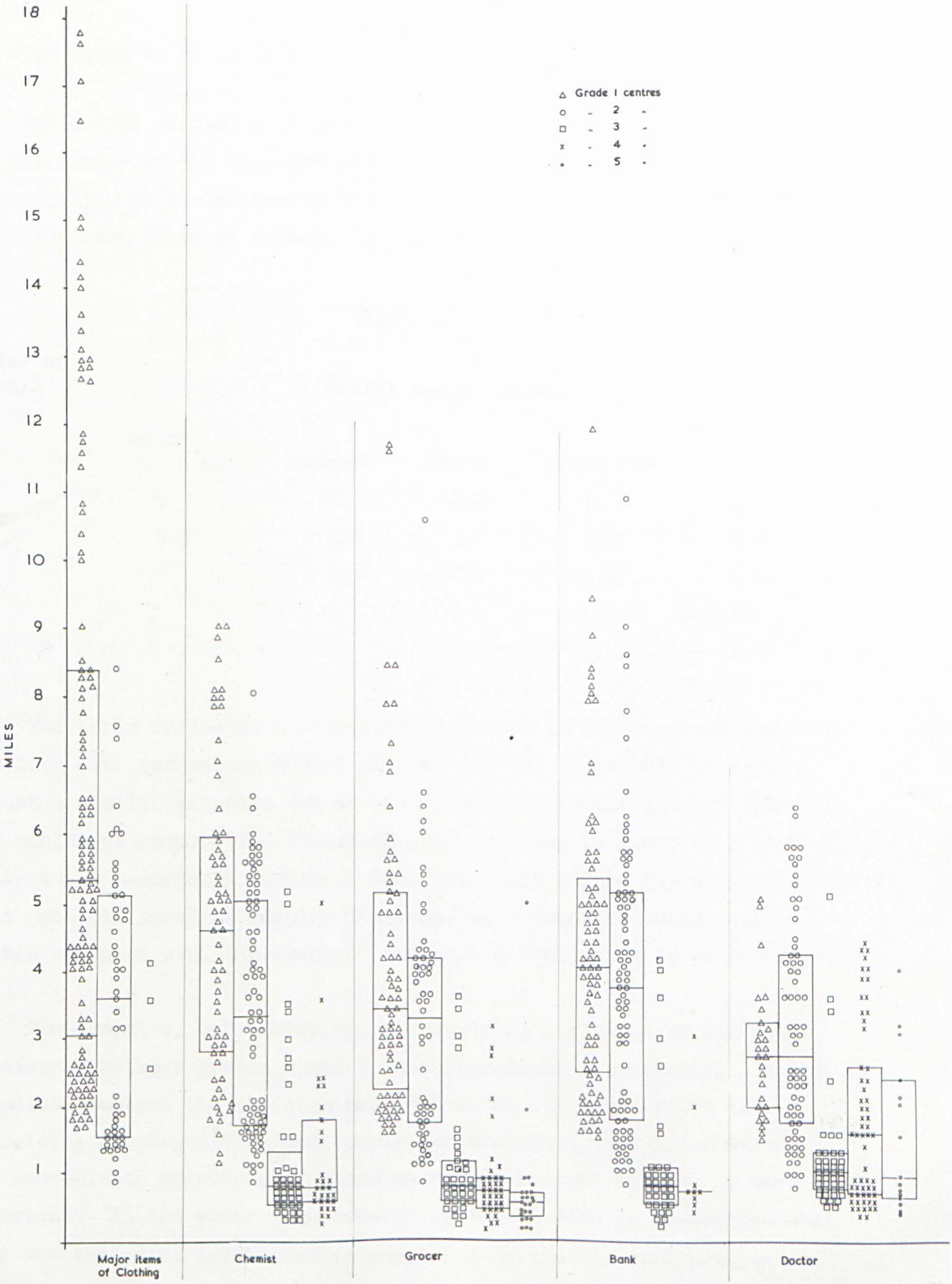
a representative list of goods created different consumer movement patterns according to the principles of convenience and competition. The second factor affecting the distance which consumers travel to make use of a service or retail function, is the status, or hierarchical order of the centre providing it.

These two factors are illustrated by Figure 7.9 which is a summary of Figures 7.4 - 7.8. Effectively it shows the ranges of three categories of retail goods and two services as provided by centres of descending order. The first point made by Figure 7.9 is the greater number of centres which emerge as nodes for lower order goods. Thus at the highest functional order, i,e. that of major items of clothing, only grade 1 and 2 centres (and grade 3 very weakly) are identified as nodes. At the lowest orders however, e.g. groceries and doctors, the nodal structure is shown to have important centres in groups 1, 2, 3, 4, and 5.

The median quartiles, i.e. the distances from which one half of the trade comes, focus our attention upon the core of the linkages in Figure 7.9. Thus it can be seen that the range for a grocery store for example is smaller for a grade 2 centre than it is for grade 1, and it decreases until it is smallest of all for a grade 5 centre. The distances travelled for a particular functional type vary more widely for consumers patronising a large centre than they do for a small centre, but the median quartiles, and the median itself, consistently represent greater distances for each individual kind of good provided by the larger centres than for comparable goods provided by lower ranking settlements.

The variation in the economic range of a good according to the rank of the centre providing it is also seen to exist for major items of clothing, chemists, banks and doctors, although the standardisation of the service offered by doctors results in only a small variation between centres of different rank. In each case the differences are confirmed

Figure 7.9 The linear range of allied groups of goods and services provided by centres of different hierarchical orders



as signficant at < 1% level of confidence by analysis of variance.

This dual variation in the range of a functional type caused both by the nature of the function itself, and the rank of the centre which provides it, is summarised in Table 7.1 where the median range of each good for each group of centres is listed.

Table 7.1

Order of Centre	Median Range (Miles)				
	Major clothing	Chemist	Bank	Groceries	Doctor
1	5.9	4.6	3.9	3.4	2.8
2	3.6	3.6	3.7	3.3	2.8
3		0.8	0.8	0.8	1.0
4		0.7	0.8	0.7	1.6
5				0.5	1.0

The table indicates a consistent decrease in the range of each function with decreasing orders of centres, but it is only in group 1 that a similar decrease can be seen according to the kind of function. The ranges of each of the functions when provided by group 2, 3, and 4 centres are remarkably similar. This table and Figure 7.9 suggest therefore that at this level of enquiry the range of a function varies very little compared with the range of the centre from which it is provided.

The dramatic, but unvarying, reduction in the range of all goods considered between grades 2 and 3 is particularly significant. In the immediate context the division may be seen as one above which the principles of competition and comparison are valid, but below which the convenience principle of shopping at the nearest outlet, is more important. In the wider view however it should also be remembered that this was the point identified in chapter 6 as the division between

settlements with a relatively complete functional array, nominally towns, and those generally termed villages with comparatively poor retail and service provision.

From this examination of the way in which rural people use urban places of different orders for the provision of a selected range of goods and services, three qualifications to the concept of the range of a good are offered.

(1) The validity of the concept may be limited to very specifically defined higher order goods, and so to higher order centres. On the other hand the majority of rural people shop so infrequently for high order goods such as jewellery, furs, furniture, prams etc., that to ask them which centres they normally use, or last used, for these purposes would probably result in a meaningless pattern of nodes and linkages.

(2) Journeys to shop cannot be resolved simply into single purpose trips to the nearest centre which stocks a required good. The multi-purpose shopping trip blurs the distinction between the theoretical range, or economic reach of various goods, and in chapter 9 further evidence will be forwarded to suggest that many of the more commonly required goods and services have an identical range in practise.

(3) The variation in the range of different goods and services should be seen alongside the equally significant variation in the range of centres of different orders. Partly this is due to the greater retail and service provision of larger centres which are consequently able to attract people from greater distances than their smaller counterparts, but it is also due to the variation in the quality and degree of sophistication of establishments of a particular functional type, and individual goods, according to the status of the centre providing them.

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Chapter 8 - The delimitation of urban hinterlands: theoretical and empirical approaches, and the nature of the boundary.

It is only through a symbiotic relationship with its surrounding district that a town possesses centrality, and Berry and Barnum [1] suggest "A system of central places develops in a region to serve consumers living in that region with the goods and services they require". Each central place has a service area (i) over which it exerts an influence, but there are many ways of measuring that influence, and of circumscribing its boundaries. Indeed the nature and extent of the hinterland for a single centre will vary not only according to the method of measurement used, but also with the level of the service specified. It will of course be determined too by the location and effectiveness of competing centres.

Each group of urban functions gives rise to its own characteristic hinterland, and local conditions may produce close correspondence or great diversity between the service areas which exist for different functions. The spatially most extensive hinterland will theoretically apply to the highest order function performed by a settlement, and the lowest order function will generate the most localised area of influence. In a study of Welsh towns Carter [2] gives many examples of different hinterlands.

Recognising that hinterland boundaries are neither static nor conclusive, and that they vary in extent for different functions we can briefly examine some of the ways in which they have been determined. In Britain the study of hinterlands has claimed the attention of geographers and town planners, for whom it has become an important tool in the examination of shopping centrestrade areas. Such studies can be divided into those which rely upon mathematical models based upon postulates, and a second group which involves the

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(i) There is little agreement over the terminology of an area which is influenced by a town. From various sources the following appear to by synonymons:- urban field, zone of influence, service or trade area, market area, tributary area, hinterland, catchment area.

use of empirical surveys. These two approaches are not exclusive however, for it is ideally only by the analysis and comparison of many different survey results that the correct variables and parameters can be identified to enable a satisfactory mathematical technique to be evolved.

Accessibility Hinterlands

A method of establishing hinterlands by an analysis of public transport patterns developed by F.H.W. Green [3] reached fruition in the 1955 Local Accessibility map produced by the Ministry of Housing and Local Government. A Town's hinterland was defined as that area which was more accessible to and from its centre than from any other. Although this approach was subsequently refined by Carruthers,[4] both studies implied that hinterlands were mutually exclusive, and as with the majority of such investigations no attempt was made to show either the extent to which hinterlands overlap, or the way in which the strength of a centre's influence varies throughout its hinterland. Accessibility hinterlands based upon public transport services indicate only a situation which is possible and not the one which necessarily exists. In addition the validity of this kind of study has been progressively eroded by the increasing importance of private transport.

Figure 8.1 indicates the accessibility hinterlands of centres in the study area as suggested by the Ministry of Housing and Local Government in 1955, compared with those constructed from 1967 bus timetable. (i) There is substantial agreement between the two periods with the exception of the emergence by 1967 of Oakengates,

(i) The local accessibility for 1967 has been calculated using the same criteria as the Ministry of Housing and Local Government 1955 Map.

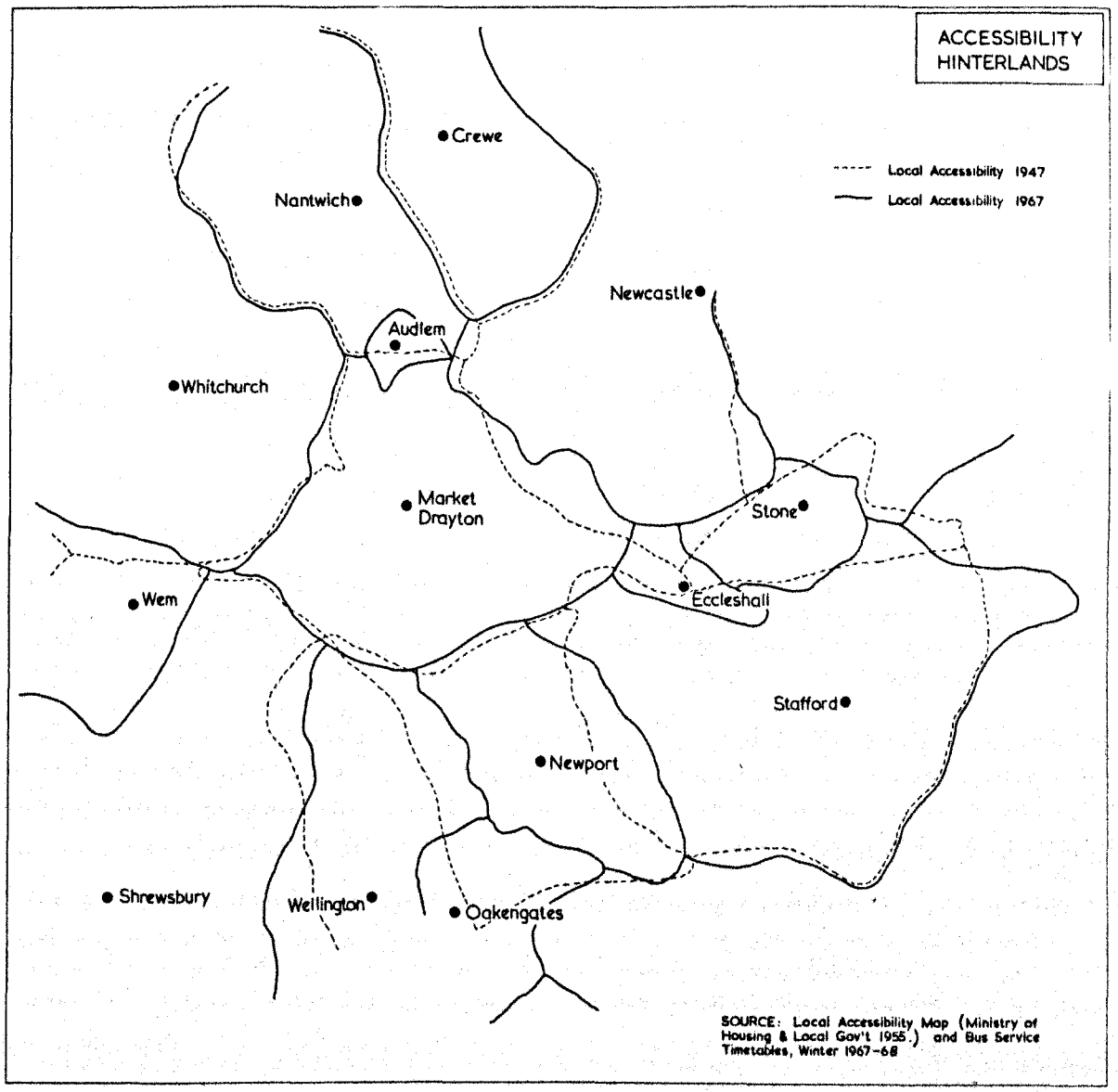

Figure 8.1 Accessibility hinterlands 1947 and 1967

Wem, Audlem and Eccleshall as centres in their own right.

Mathematical Models

Gravity and potential models have been applied extensively by geographers and economists to the investigation of central place systems, and by planners to the study of market areas and the attraction of shopping centres. The recent study by Smailes[5] in Australia provides a good example of the techniques involved.

The basis of most gravity models is to equate some measure of the attraction between two locations with the friction caused by the distance between them, and there is a direct corollary with Newtonian physics. The early development of models of this kind has been comprehensively reviewed by Carruthers[6] so further discussion here will be brief. The attraction (or in Newtonian terms the relative mass) of centres has been variously measured in terms of population,[7] retail stores or sales,[8] or by an index of interaction such as telephone calls,[9] and two kinds of generically similar models have evolved.

The first, a deterministic form, is a direct development of Reilly's Law of Retail Gravitation[10] and it is commonly used to establish the break point, or the line of equal competition between adjacent centres. In mathematical terms

$$Db = \frac{Dab}{1 + \sqrt{\frac{Pa}{Pb}}}$$

Db = Distance of break point from town b
Dab= Distance from town a to town b
Pa = Population of town a
Pb = Population of town b

Figure 8.2 illustrates the hinterlands which result from this formula for the study area. Here road distances have been converted to travel time in minutes (i) and the weighting factors

(i) Travel times are calculated from the following average speeds. Unclassified roads and urban roads 20mph. Classified A and B roads 30 mph. Trunk roads and dual carriageways 40 mph.

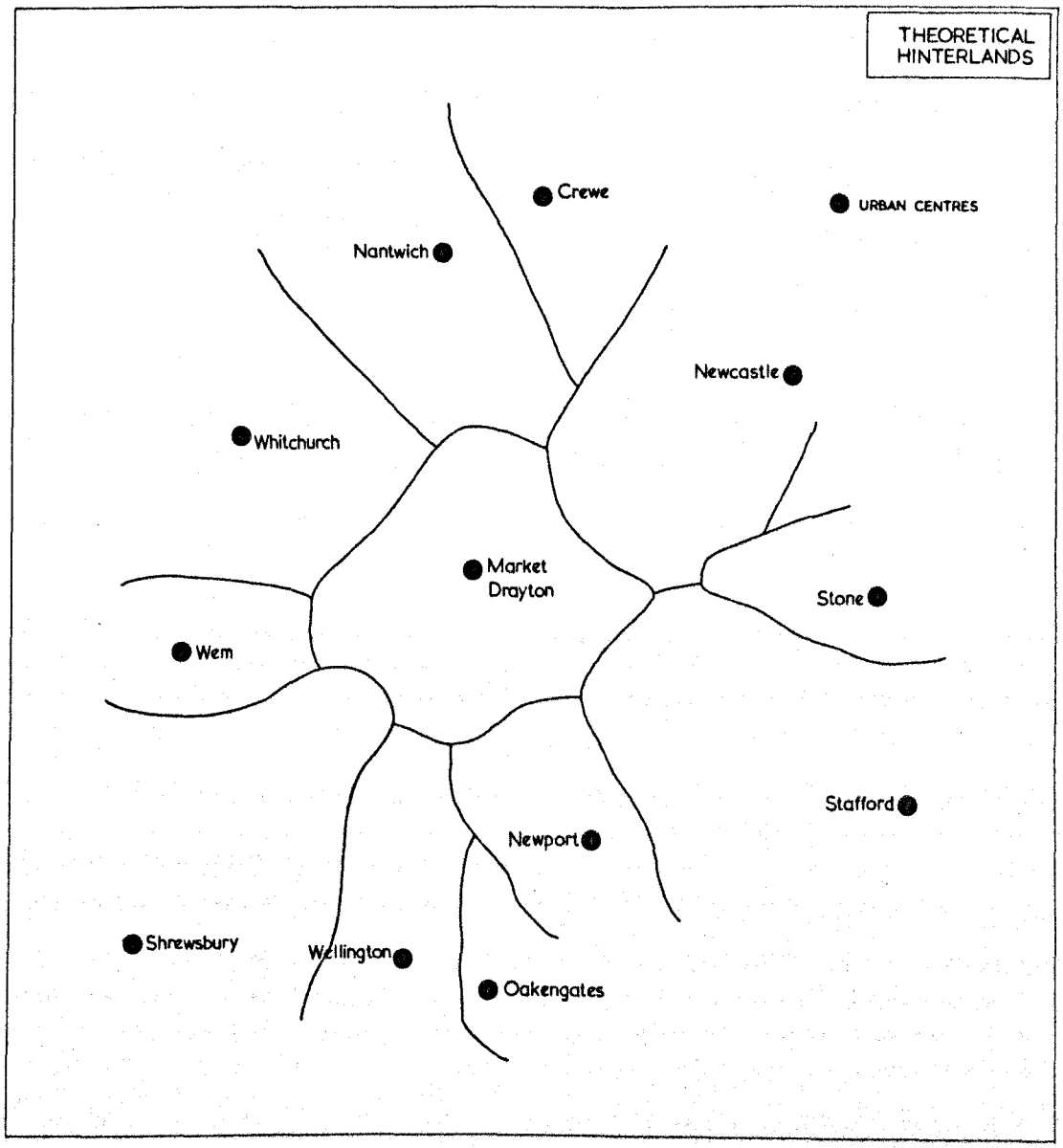

Figure 8.2 Theoretical hinterlands for urban centres calculated from Reilly's Law

Pa and Pb are the total centrality scores for each centre as derived in Chapter 3. All urban centres regardless of grade have been assigned a service hinterland which is dependant purely upon the centre's weighting and the distance to the next town, as if in a single order hierarchy. Towns at higher levels in the hierarchy however will have, for some functions, hinterlands which exceed and overlap those of lower order settlements, and for this reason figure 8.3 presents a calculation of separate hinterlands for grade 1 and 2 centres. (ii).

In Figure 8.3 it has been assumed that grade 1 centres offer all of the facilities of grade 2 settlements, with the addition of other functions which elevate them to the superior grade. Thus in order to construct grade 2 hinterlands for the grade 1 centres each of the latter has been given a weighting equivalent to the average for grade 2 centres. The theoretical hinterlands of the large towns as shown in Figure 8.2 are seen from Figure 8.3 to be a compromise between their grade 1 and 2 hinterlands.

These two maps embodying results based upon a predictive model can now be compared with the empirical survey results mapped in Figure 8.4 . There hinterlands for all urban centres have been constructed without reference to the order of goods being provided, or the grade of the centre and it depicts actual movement patterns. The boundaries shown result from an analysis of the replies of a random sample of rural people to the simple question "which towns have you visited for shopping purposes in the past four weeks?"

Broad similarities will be noted between Figures 8.2, 8.3 and 8.4,

(ii) These grades are as identified in Chapter 6.

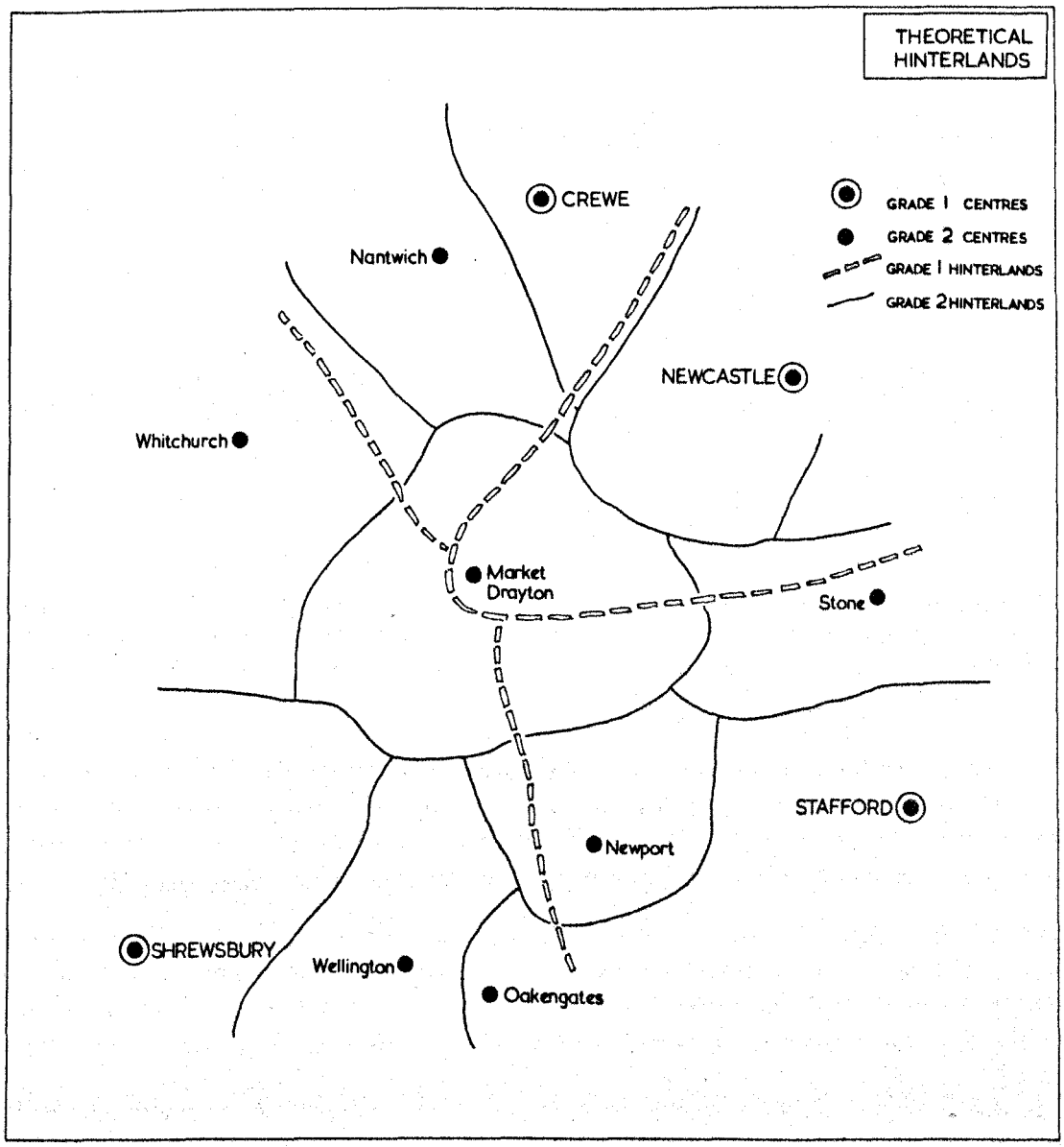

Figure 8.3 Theoretical hinterlands for grade 1 and grade 2 centres calculated from Reilly's Law

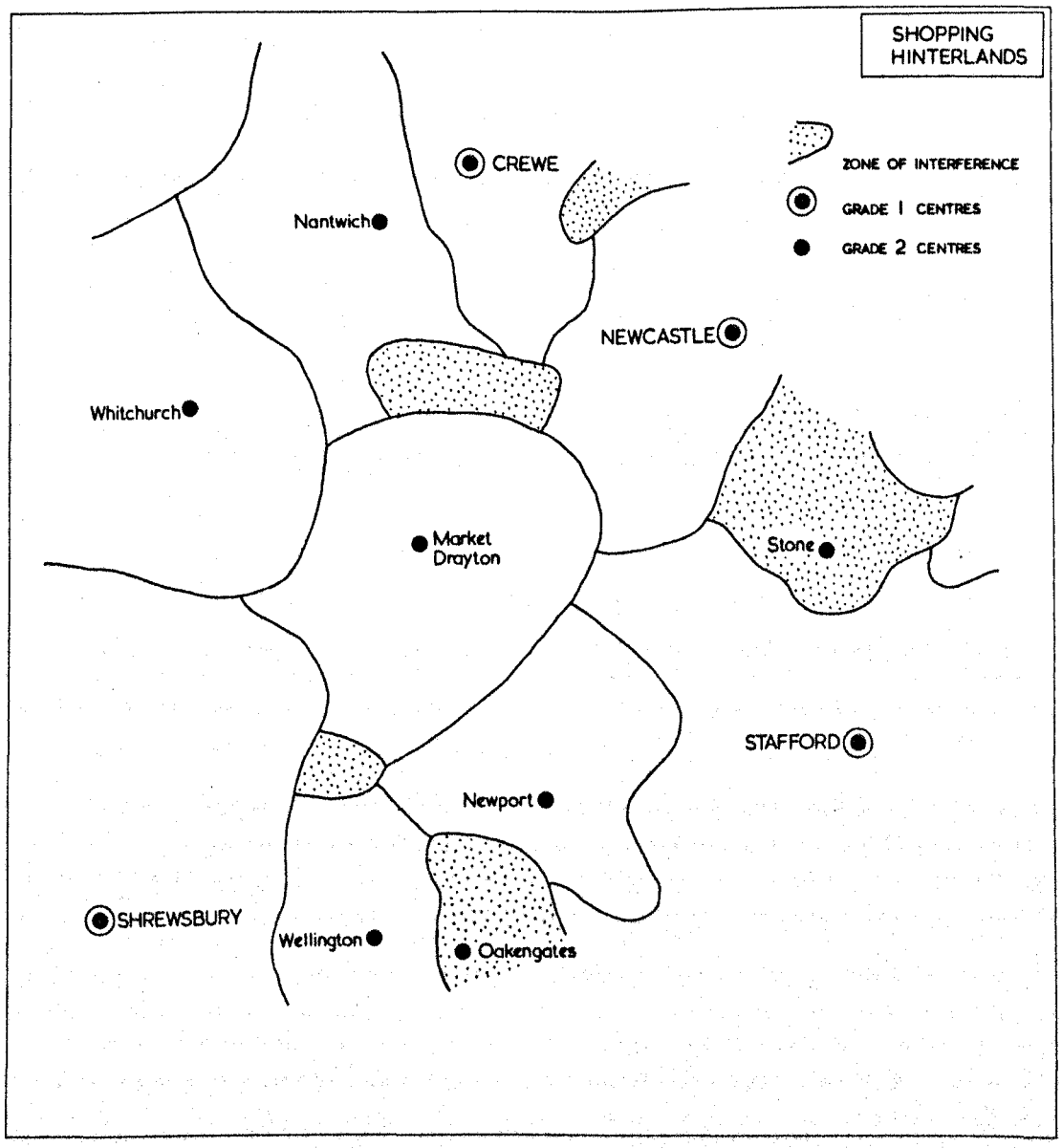

Figure 8.4 The shopping hinterlands of grade 1 and grade 2 centres

but Figure 8.4 shows two important divergences from the theoretical situation. The first difference is the irresolute nature of the boundaries thenselves. The stippled areas represent zones of interference between the influences of two or more towns. From these localities journeys to town are split between several centres with no single town claiming even 50 percent of the total. In this respect the zones of interference are areas which lie outside of the dominating influence of any individual town.

Secondly local discrepancies between the three figures suggest that extreme caution should be attached to the use of gravity models for measuring the market areas of anything other than large and well separated towns. For example the way in which the hinterlands of Newcastle and Stafford extend north and south at the expense of those of Market Drayton and Stone reflects the local north-south alignment of communications along the Trent valley. Similarly the westward extension of Newport's catchment area can be accounted for by the barrier to communications originally provided by the Weald Moor area to the north of Oakengates and Wellington. Even by turning distance into travel time for calculating the 'model' statement of Figures 8.2 and 8.3, the geographical idiosyncracies are not truly reflected.

More sophisicated and flexible models have been developed by Huff,[11] and Lakshmanan and Hansen[12] who diverge from previous deterministic techniques to produce probablistic and non-unique solutions. Briefly these concepts allow a consumer to isolate a subset of alternative shopping centres, to calculate their relative utility and then to distribute his partonage spatially in a probablistic fashion and not necessarily to a single centre.

Expressed in model form this becomes,

$$P(Cij) = \frac{\frac{Sj}{Tij^{\lambda}}}{\sum_{j=1}^{n} \left(\frac{Sj}{Tij^{\lambda}} \right)}$$

where

$P(Cij)$ = Probability that shoppers in zone i go to centre j.

Sj = Floorspace for particular product in centre j.

Tij = Travel time from i → j.

λ = Travel time exponent (empirically estimated).

Hinterlands of shopping allegiance can thus be expressed by probability contours surrounding a centre; these will overlap for competing centres and give a more realistic identification of trade areas than a single, exclusive hinterland line. The representation of a town's zone of influence by a single boundary line contains several implied fallicies. The first of these is the implication that hinterlands are exclusive and that a clean division, usually taken as the 50 percent break point, exists between the catchment areas of competing towns. Secondly, a single line suggests that a hinterland is a relatively uniform area, all parts of it being linked with equal strength and frequency of contact to the centre. The first of these questions properly belongs here, but the discussion of the structural complexity within the hinterland will be explored more fully in the following chapter.

Overlap of hinterlands.

It has already been shown in Figure 8.4 that zones of interference, or multiple competition exist where no single centre dominates rural allegiance by claiming even 50 percent of all journeys to town, but in addition the pattern of influence is far from simple, even where the hinterlands of only two towns impinge. To represent a hinterland boundary by a single line drawn where the influence of town A becomes greater than that of town B is to ignore the possibility that the two hinterlands overlap deeply.

Within this zone of overlap between two centres of the same hierarchical order, the consumer is faced with a multiple choice situation, and the questionnaire survey revealed that from either side of the half way line shopping journeys were made to both centres, although for the individual, one town (not necessarily the nearest) remained overwhelmingly dominant.

The strength of this allegiance to one centre decreases where towns of comparable rank are close together. For example, within a six mile zone straddling the boundaries of the hinterlands of Newcastle, Stafford and Shrewsbury (average distance apart 24.2 miles), less than 5 percent of the respondents to the questionnaire had visited two of the centres during the month prior to the survey. Between Newcastle and Crewe however, (distance apart = 10.6 miles) 16 percent of respondents in a similar zone had split their visits between the two towns.

From this evidence it could be suggested that the sharpness of hinterland separation is itself a function of distance, although in this case the distance being considered is that between competing towns. The decision to use one town habitually, or a number in rotation does not appear to depend greatly upon the order of the goods being purchased. With the exception of occasional visits to towns outside the area, consumers were found to use one town as consistently for high order goods as they did for low order ones.

At the junction of the hinterlands of the smaller towns the situation is more complex, and there are many cross currents. Within a six mile zone astride the hinterland boundaries of grade 2 towns, approximately one fifth of respondents divided their shopping trips between two centres. This is not an equal division, and for the individual, one of the centres invariably claimed many more visits than the other. This relatively high proportion of

'floating consumers' at the boundaries between the competing influences of small towns is partly accounted for by the smaller distances of separation than for the grade 1 centres, but it is also a reflection on the fact that small centres cannot dominate a hinterland, even one proportional to their size, so strongly as can the larger towns.

Further analysis of the movement patterns of rural shoppers indicates that although there is substantial spatial overlap between the zones of influence of adjacent centres of similar rank, in behavioural terms the overlap is more illusory than real. Spatial overlap of the zones of influence of adjacent towns can be conceived as the ability of one town to attract customers from within what is properly considered another town's hinterland.(i). Behavioural overlap on the other hand is concerned with the way in which individual consumers distribute their patronage between competing centres, and particularly whether they visit two or more towns of the same order. Thus in the study area, spatial overlap was found to be commonplace, and indeed inevitable, but behavioural overlap could rarely be demonstrated since only a very small proportion of individual consumers used two centres of the same rank alternately and indifferently. Thus there is a clear pattern of individual loyalty to a particular town but no clear pattern of territorial allegiance.

In Table 8.1 the way in which respondents had used towns, singly or multiply, for shopping purposes is tabulated. It shows that approximately 43 percent of all respondents had visited only one town in the month prior to the survey, but 50.4 of those

(i) i.e. where the second town's influence is greater but still does not amount to complete dominance.

questioned had visited more than one. This is certainly suggestive of an overlap in the zones of influence of the various towns, but it should be noted that the multiple use of centres indicated here is more complementary than competitive. For example, a further breakdown of the figures reveals that only 5.7 percent of all respondents had visited more than one grade 1 town, and that only 7.6 percent had split their visits between competing grade 2 centres.

Table 8.1

Proportion of respondents who had visited 0 towns	6.8%
Proportion of respondents who had visited 1 town	42.8%
Proportion of respondents who had visited 2 towns	32.3%
Proportion of respondents who had visited 3 towns	13.7%
Proportion of respondents who had visited more than 3 towns	4.5%

A more meaningful measure of the way in which a single centre dominates individual consumer movement is gained from an analysis of the destination of shopping trips, and by calculating the proportion of all shopping journeys which are made to individual specified towns. In this instance the strength of the ties between a consumer and his/her single, dominant town is substantiated by the fact that nearly 80% of all shopping journeys recorded were made to the consumer's premier, or first choice town — Table 8.2.

Table 8.2.

Proportion of all shopping journeys which were made to consumer's premier town	79.0%
Proportion of all shopping journeys which were made to consumer's secondary town	16.0%
Proportion of all shopping journeys which were made to consumer's tertiary town	3.6%
Proportion of all shopping journeys which were made to other towns	0.8%

Thus although a half of all consumers had visited more than one town, the proportion of all shopping visits to towns other than the premier centre was relatively small.(i) Of visits to second

(i) Even among respondents who had visited more than one town, and who could therefore be considered a more mobile element of the overall sample, 71.4 percent of all visits were made to the premier town, 26 percent were to second choice towns and 2.6 percent to 3rd and 4th choice centres.

choice towns, nearly three quarters were made to centres larger than the respondent's premier town. These included many towns outside of the area such as Manchester, Birmingham and London thus reinforcing the earlier contention that the use of different centres is complementary rather than competitive. In summary, the pattern which emerges is one in which a single town is strongly dominant for each rural person, and although one person in two had visited alternative shopping centres during the survey month, such visits accounted for only one-fifth of all shopping journeys.

In the identification of the nodal structure of the area we saw how a town's zone of influence could vary according to the nature of the good or service being considered. The fixing of the boundary of this influence on the basis of use characteristics has now revealed further variation. In particular the suggestion that such a boundary can be represented by a single line is questioned. Town hinterlands are not exclusive and they do overlap spatially. The existence of areas of interference indicates that the study area cannot be divided completely into sub areas each dominated by a single town. In contrast, behavioural patterns illustrate how, for the provision of shopping and service facilities, individual consumers are dominated by a single town.

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Chapter 9 - Hinterlands of rural-urban interaction; the structure of the hinterland.

It has been demonstrated that the statement of a town's hinterland boundary as a single line is a gross oversimplification. In addition it can be noted that most hinterland studies fail to describe the nature of the zones of influence which they identify, in particular they make no attempt to describe or explain the variations of strength and intensity with which different parts of a rural hinterland are linked to the urban centre. This chapter has two closely linked functions. Firstly, it explains the distance-decay function in urban-rural influence and examines the structural components of hinterlands, and secondly it discusses and draws contrasts between the decay of influence with distance at varying levels in the hierarchy of centres.

The affiliation between town and hinterland is frequently found to follow a simple exponential distance-decay function, similar to that noted by Clark [1] in 1951 and subsequently refined by Muth [2] and Berry, Simmons and Tenant, [3] but in other cases it is far less regular.

It is usually accepted that a servce centre exerts some degree of influence, which may amount to dominance, over its hinterland, but the precise nature and strength of this dominance is rarely explored. Some attention has been paid to the problem previously by Anderson and Collier, [4] Martin, [5] Stoeckel and Beegle, [6] and Bogue, [7] but such works are few.

Since the concept of dominance is clearly a crucial aspect of central place study it must be briefly discussed in general before proceeding to the detailed empirical study. For the present the term dominance is taken to imply the authority of town over country, but it is important to note that this is not entirely a one-sided

relationship; the recreational hinterland of a town and the provision of agricultural products are obverse measures which show that there is a relationship of interdependence of town and country. Theoretically, dominance decays most rapidly with distance for lower order goods and services, for such goods are provided by a large number of major and minor centres. Conversely, for higher order urban functions where the central town has little or no competition from minor service centres, the influence can be exerted over a far greater area, and the distance decay function is more gentle.

It is not however true in every sense that the dominance of a town decreases with distance. For example, if, within a town's hinterland a consumer requires a good or service that can only be provided by the central town, then the dominance of this town, at that particular level is equallypervasive throughout its hinterland. Frequently this results in a marginally lower standard of living, expressed as a lower level and frequency of demand for the more sophisticated urban functions by rural people who live at a substantial distance from a large town. The degree of dominance of any place can therefore become measurable in terms of the frequency with which it is used by people living at varying distances from it.

General nature of the urban influence

It was hypothesised that the spatial organisation and behaviour of a rural population could be seen in terms of a series of gradients, in which the distance away from a central place was the main independent variable. The evidence discussed below shows that in some instances this is a valid assumption, and the gradients of influence frequently have a negative exponential form described in general terms by the

equation

$$Y = Ae^{-bx}$$

Y = the dependent variable, i.e. some measure of the strength of affiliation of a rural population to an urban centre

x = distance from that centre

A)= coefficents determined empirically
b)

Rural Population density and distance

In order to achieve some point of contact with previous work, the first characteristic to be examined was the distance decay effect in rural population density. As in the other examples which follow only the population of rural districts was considered, and its decreasing density with increasing distance away from the major towns is a corollary to the decreased found by Berry, Simmons and Tenant [8] in suburban areas. This decline of population density in rural areas in many respects represents a natural extension of towns past their artificial administrative boundaries, and it is of course an expression of population mobility. The fact that this gradient could only be identified and measured around the grade 1 centres in the study area shows that the smaller centres do not have sufficient status,or influence, or provide a sufficiently large employment centre to shape the surrounding population distribution in a centripetal pattern.

The population density of the rural areas was calculated on a parish basis, but where these units were areally large they were subdivided into enumeration districts. Parishes were then allocated to towns according to hinterland boundaries drawn equidistant from centres of the same order, and distances were measured between the towns and the centre of population gravity of each parish by the shortest practicable road mileage.

The population density at increasing distances from the four grade 1 towns was plotted, and the results are shown in Figure 9.1. This is a composite graph, but none of the individual centres have distance decay relationships which vary appreciably from this overall line. The reason for aggregating the figures and plotting the towns together is that here, as elsewhere in the chapter, the emphasis is not upon individual, and perhaps anomolous cases, but upon the trends and characteristics shown by groups of centres at different levels of the urban hierarchy. When measured against distance from grade 1 towns the rural population density is seen to decline with increasing distance, and although there are minor aberrations of the pattern caused by occasional large parishes, the overall trend is one of exponential decline.

The y-axis of Figure 9.1 gives the natural logarithm of population density (in hundreds per square mile) and the abscissa shows distance from the town centre in miles. Extrapolation of the gradient gives the coefficient A a value of 6.7. This figure nominally represents the population density in the town centres, i.e. where distance is zero. But it is not legitimate to use the gradient for making predictions outside of the range within which the original data was compiled. For this reason there is no meaningful advantage to be gained by attempting to convert the coefficient of 6.7 into an actual population density figure. Similarly there is no purpose in extending the line past 14 miles on the x-axis. The coefficient b, which is a measure of the rate of decline of population density, is given by the gradient of the line; here $b = 0.24$. The correlation between population density and the distance from a grade 1 centre was found to be $r = -0.95$.

Rural Population trends and distance.

The influence of first order towns upon rural population change was found to be fundamental, but it was not of a measurable

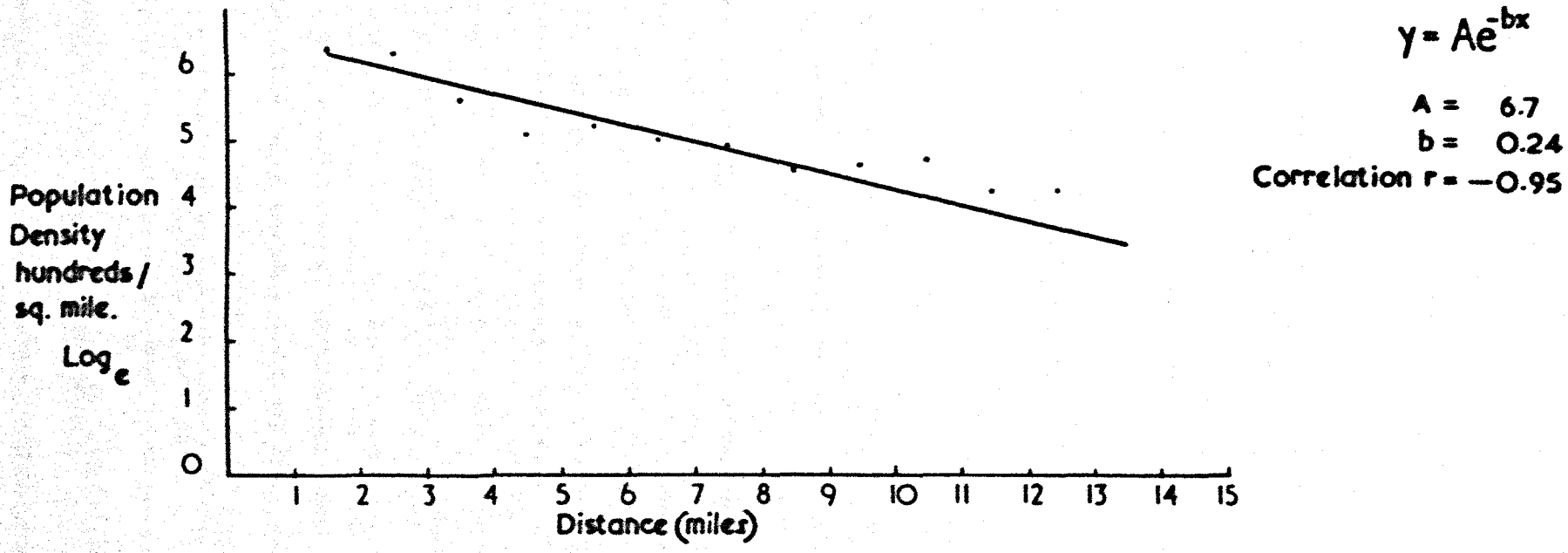


Figure 9.1 The distance-decay gradient of population density

exponential form. The relationship between population change and distance from a town is not a regular one, but initially we can identify three concentric zones around the towns of this area. These zones are not constant, and it is possible to show that they have changed in their extent and location over the past few decades. At the present point in time they are identifiable as follows:-

1. Up to a distance of four miles from the centre of towns there has been considerable housing development which has both created and catered for short range commuters. This relatively recent extension of the towns outside of their administrative boundaries is in response to both 'push' and 'pull' factors. The shortage of sufficient cheap building land within the towns has tended to push development out into the immediate rural areas, but this has also been supplemented by the positive choice of many people to live in villages and out of town estates where they gain not only social prestige, but also an improvement in physical living conditions. The common factor which has made both of these processes possible is the growth of public, and more particularly, private transport. Within this inner belt there was a 22 percent increase in 'rural' population in the decade 1951-1961, and 80 percent of the parishes showed gains.

2. Between four and nine miles from the main urban centres there is a belt of limited growth where 40 percent of all parishes had increased in population. The growth in this band has been fairly modest but again it is in response to demands by commuters for out of town homes. Partly it has been encouraged by county planning authorities who have nominated certain villages for expansion, but it also takes the form of the development, or reconstruction of individual sites and buildings by private persons. During the decade 1951-1961 the pattern of growth was more irregular and scattered than in the inner band, but the overall population

increase was 5.6 percent.

3. At a distance greater than nine miles from major towns very few parishes showed any population increase in the years 1951-1961, and there was an overall decrease of 10.4 percent. These areas are almost purely agricultural; the demand for farmworkers is declining, very few new employment opportunities are being created, and the towns are too far away for convenient daily commuting, so here in microcosm is an example of the kind of rural population decline which affects much of the north and west of Britain.

The close association between parish population changes in the decade 1951-1961 and distance from the main urban centres is shown by a correlation coefficient of — 0.89 (significant at the 0.1 percent level). This degree of correlation, together with the evidence discussed above suggests that proximity to a major town is a strong determinant of rural population change, it also serves as an indication of the attractive power of first order towns as employment and service centres for their surrounding 'rural' populations.

This brief examination of population growth contributes to the overall study in that it looks at another component in the complex pattern of town hinterlands. It also has a practical value in that it describes an aspect of the changing distribution of purchasing power which is being increasingly concentrated in the areas adjacent to urban centres.

Distance-Decay and the retail function

There are many factors which influence the frequency of an individual's shopping visits to any particular town, for example the rank and size of the town, the adequacy of local shops and services within the countryside, the level of personal mobility of the rural

population and its purchasing power, but it was postulated that distance from the town would be a major determining factor. (i)

In order to explore this relationship, isochrones of travel time by car were drawn around each town, and the frequency of visits by rural people to each centre was graphed against their travel times. (ii) To emphasise the different use characteristics of towns of different rank the centres were divided into two groups as detailed in table 6.3. Group 1 included Newcastle, Crewe, Stafford and Shrewsbury with a population range of 76,000 - 48,000, and group 2 comprised seven other towns ranging from a population of 13,650 - 4,370.

In each case an exponential line of the general form $Y = Ae^{-bx}$ provided a good fit to the data and the individual frequency/distance relationships are shown in Figure 9.2. Among grade 1 centres, Shrewsbury's influence declines rather more gently than the rest due to its more isolated westerly location, in an area of generally low population density, but there is marked similarity in all the relationships. Similarly, grade 2 towns are very much alike with the possible exception of Nantwich, which is not only slightly larger than other grade 2 centres but also has the advantage of many 'quality' shops.

In the search for any more general relationships which might lie behind individual distance decay functions and their possible idiosyncracies and anomolies, figure 9.3 was prepared. This figure

(i) "The spatial distribution of human activity reflects an ordered adjustment to the factor of distance". Garner B.J. in Chorley R.J. and Hagget P (Eds.) Socio-Economic Models in Geography, Methuen 1969, p. 304.

(ii) These were calculated according to the average speeds recommended in "The Haydock Study, Regional Shopping Centres in N.W. England. University of Manchester 1964. viz. Trunk roads 40m.p.h., main roads 30m.p.h., urban and minor country roads 20m.p.h. 73 percent of respondents had access to a car for shopping purposes.

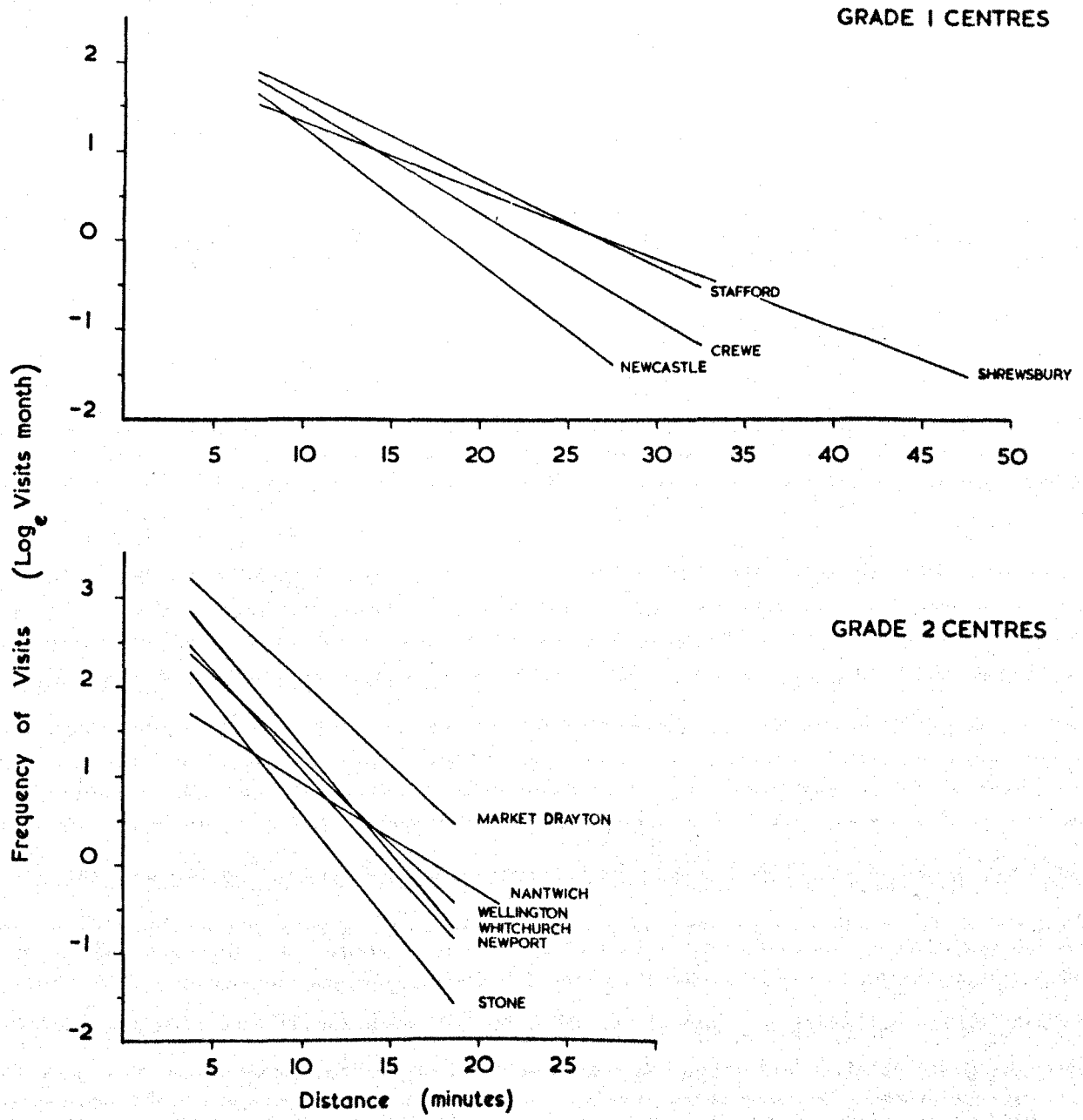
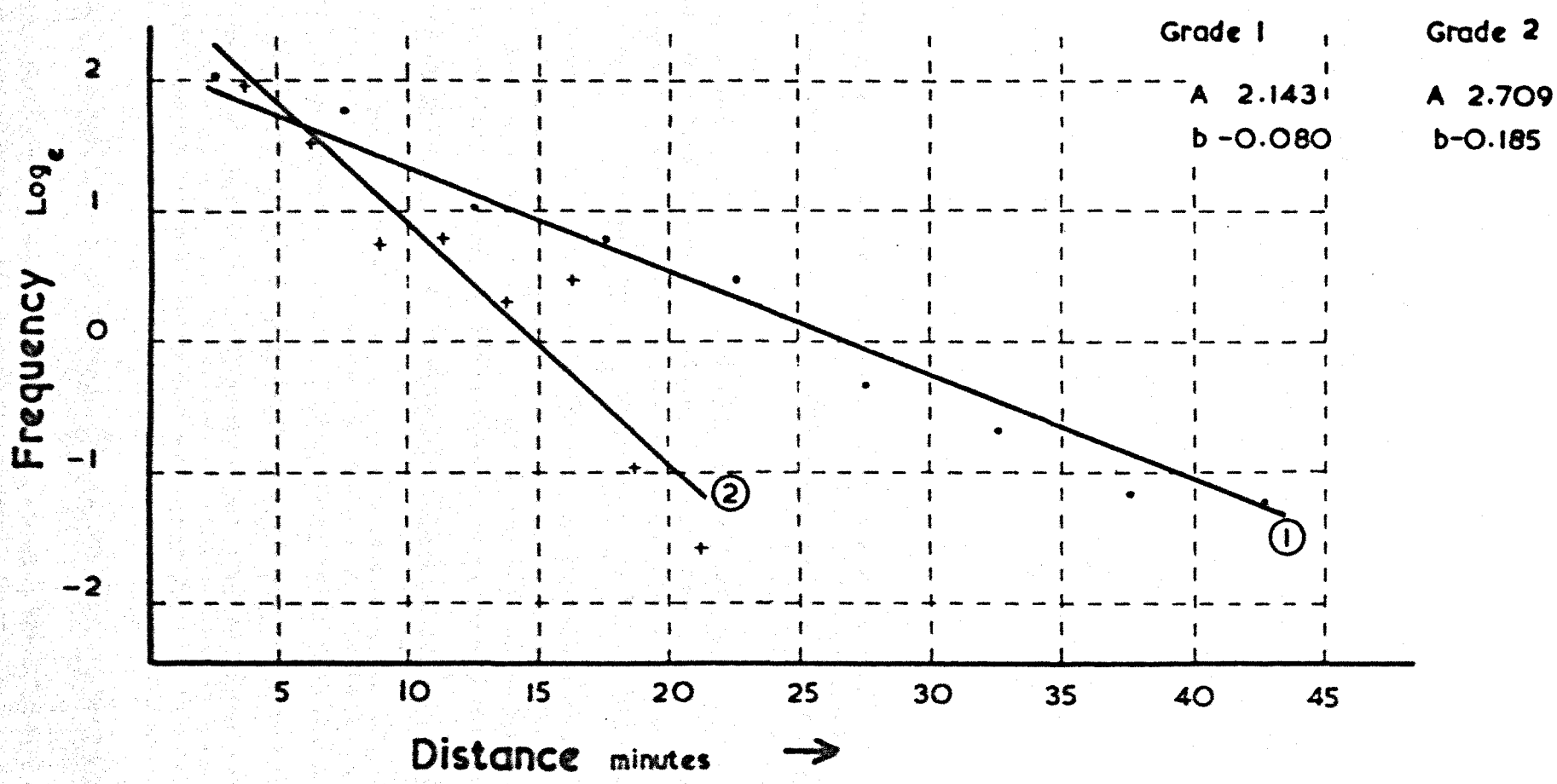


Figure 9.2 The distance-decay gradient of shopping frequency for grade 1 and grade 2 centres

Figure 9.3 The composite distance decay gradient of shopping frequency



represents the aggregated distance decay functions of shopping frequency for the two groups of towns, and it emphasises the difference between the use characteristics of grade 1 and 2 centres which was implicit in Figure 9.2. The contrasting nature of the influence of the two groups of centres, and of their rural-urban linkages, is quantified by the slope of lines, i.e. the b coefficient. Grade 1 centres, with the smaller b coefficient (b= -0.080) have a relatively gentle gradient of distance decay, to a maximum range of 45 minutes, at which point the frequency of visiting was about once in four months. The influence of grade 2 centres however declined more rapidly, as evidenced by a gradient of b = -0.185, and a maximum range of 22.5 minutes travel time. At this extremity visits per respondent averaged approximately one in five months.

These gradients should be seen as a postulated basic relationship, an attempt to quantify and explain the general pattern of urban domination of rural areas, and as an illustration of the distinction between centres of different orders within a particular urban system. In chapter 6 the decision to separate these towns into two groups was taken upon the basis of their functional provision. This division is now substantiated, and shown to be a realistic one by the evidence of the differences in the influence which the two groups of towns exert over their surrounding rural hinterlands. In this way the study of distance decay functions has a valid role to play in the identification of central place relationships and the subsequent resolution of hierarchical groups.

It should not be concluded that grade 1 centres are situated 90 minutes travel time apart, and grade 2 centres 45 minutes apart, for the basic relationship conceals the fact that there is considerable overlap between the fields of influence of adjacent centres. In particular cases too the local road network can compress or extend

the fields of influence. Thus the towns of Stone and Oakengates are both weak grade 2 centres due to competition from Newcastle and Stafford in the former case and Wellington and Newport in the latter.

The distance decay function is a general statement of urban influence,but it conceals many of the irregularities in the shape and extent of individual hinterlands. Figure 9.4 shows the shopping hinterlands of Grade 1 towns, and considerable variation is evident in the nature of the areas which are dominated by each centre. The broken line in figure 9.4., here called the 50 percent urban field, is the break point, where adjacent towns are equal in attraction. It encloses the area from which at least 50 percentof locally generated shopping trips are made to the central town, and it is an example of the over-simplified concept that an urban hinterland may be seen as a single boundary line. It is a convenient illustration of the general extent of urban hinterlands, but it involves considerable arbitrary generalisations and in effect it conceals as much of the truth as it reveals.

That a single boundary line obscures the variations in intensity with which different parts of a hinterland are linked to a town is shown in figure 9.4 by the construction of further isopleths enclosing the areas within which (say) 70 percent and 90 percent of shopping journeys are made to the centre being examined. The construction of these isopleths represents a change of emphasis from the previous discussion of distance decay functions; here the rural-urban linkage is being measured not by the frequency of visits to each town, but by the proportion of all grade 1 shopping visits from each area which are made to each of the four grade 1 centres being considered. In this case the intensity of the interaction does not depend purely upon distance; the zones within which 90 percent, 70 percent and 50 percent of journeys are made to one centre, unlike the zones of frequency are not concentric, but

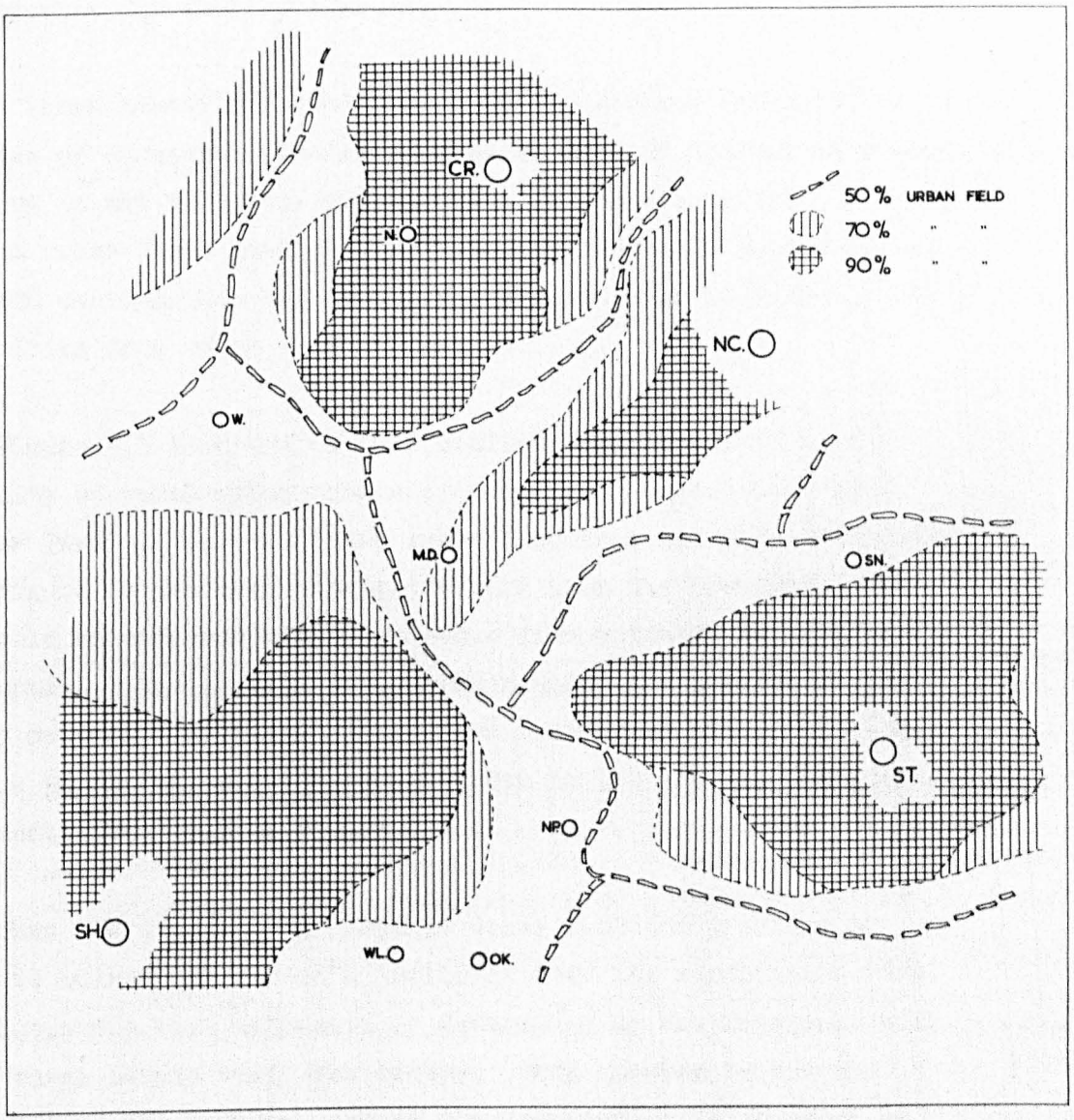


Figure 9.4 The varying intensity of the retail hinterlands of grade 1 centres

depending upon the alignment of local transport networks and the degree of competition from other centres, the three isopleths can run together for short distances.

A large hinterland enclosed by the 90 percent isopleth, as in the case of Shrewsbury indicates a large area of domination where the town is not seriously challenged as a grade 1 centre. A small 90 percent urban field however, as shown for Newcastle suggests that the town can dominate only a small area, and that it suffers severe competition from other, nearby centres.

Figure 9.5 illustrates that similar isopleths showing the intensity of rural-urban interaction may also be constructed at a finer level of enquiry (here grade 2 centres are also included). This figure is far less straightforward than the previous one and it should be compared with Figure 8.4 from which it is a natural development. The areas of interference which lie outside of any simply defined hinterland pattern are again seen to be important, and the 90 percent and 70 percent urban fields are all considerably more restricted than in figure 9.4.

Thus the exponential distance decay function provides an adequate measure of a town's influence over its surrounding rural district, where that influence is determined by the frequency with which rural people visit the centre. This however is but one dimension of the problem, and if the interaction is measured as a proportion of all rurally generated shopping trips attracted to the town, its intensity is seen from figures 9.4 and 9.5 to vary in strength and extent throughout the hinterland. To consider a hinterland boundary as a single line is artificial, for not only does it obscure variations in the intensity of hinterland affiliation, but it also conceals areas where no individual town is dominant.

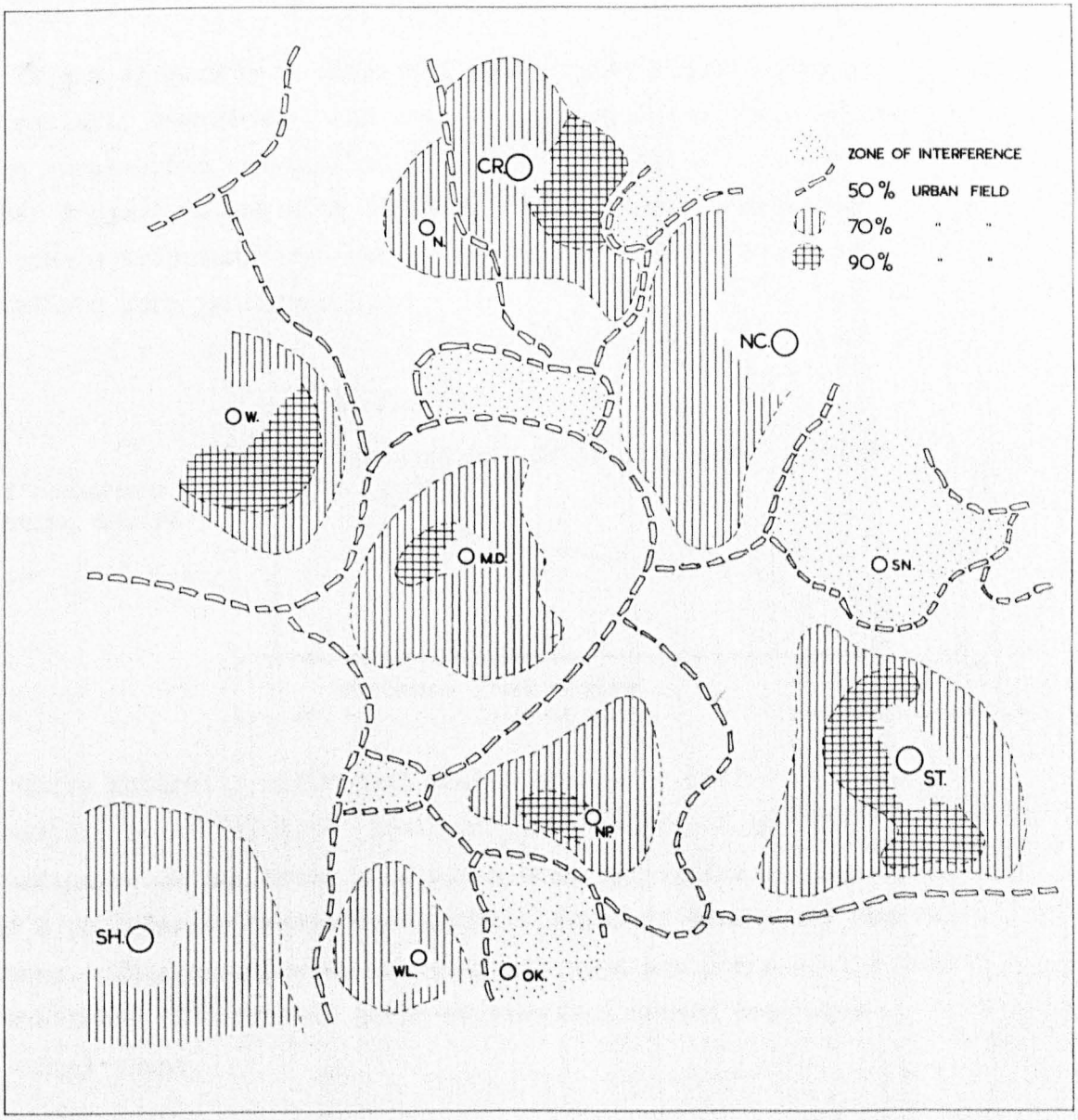
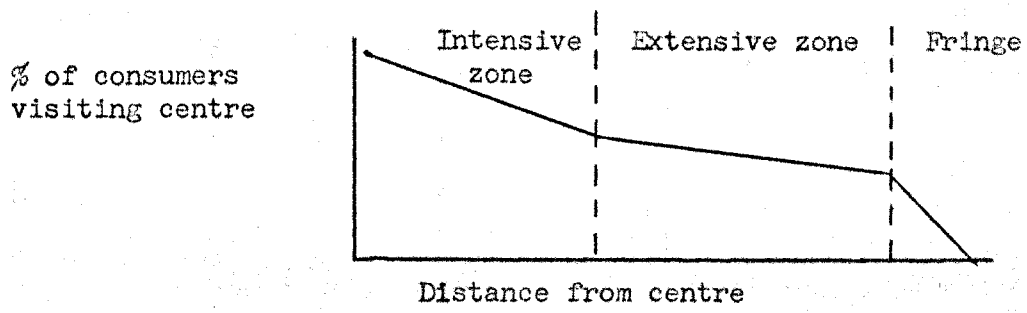


Figure 9.5 The varying intensity of the retail hinterlands of grade 1 and grade 2 centres (cf. Figure 8.4)

Structural components of the urban hinterland

It has already been suggested that a town's hinterland is not spatially homogenous. and that in general terms the strength of the rural-urban interaction decays with distance. We can further suggest, along with Golledge [9] that three components of a town's tributary area can be recognised. These are shown in stylised form in figure 9.6.

Figure 9.6.



Quite naturally, individual town hinterlands differ from one another due to a variety of local circumstances, but in the discussion below the towns have again been aggregated into groups 1 and 2 in order to permit the identification of common and general patterns. This also places the emphasis upon the order of the town and the level of different goods or services rather than upon individual towns.

Figure 9.7. indicates the proportion of people within five minute distance bands from each centre, who used grade 1 and 2 towns for each of a selective range of eight goods and services. For the construction of this figure, concentric isochrones of travel time were drawn around each centre, from the questionnaire it was possible to calculate the percentage of respondents in each distance band who nomiated each town as their normal centre for the purchase of each good or service. The three zonal components

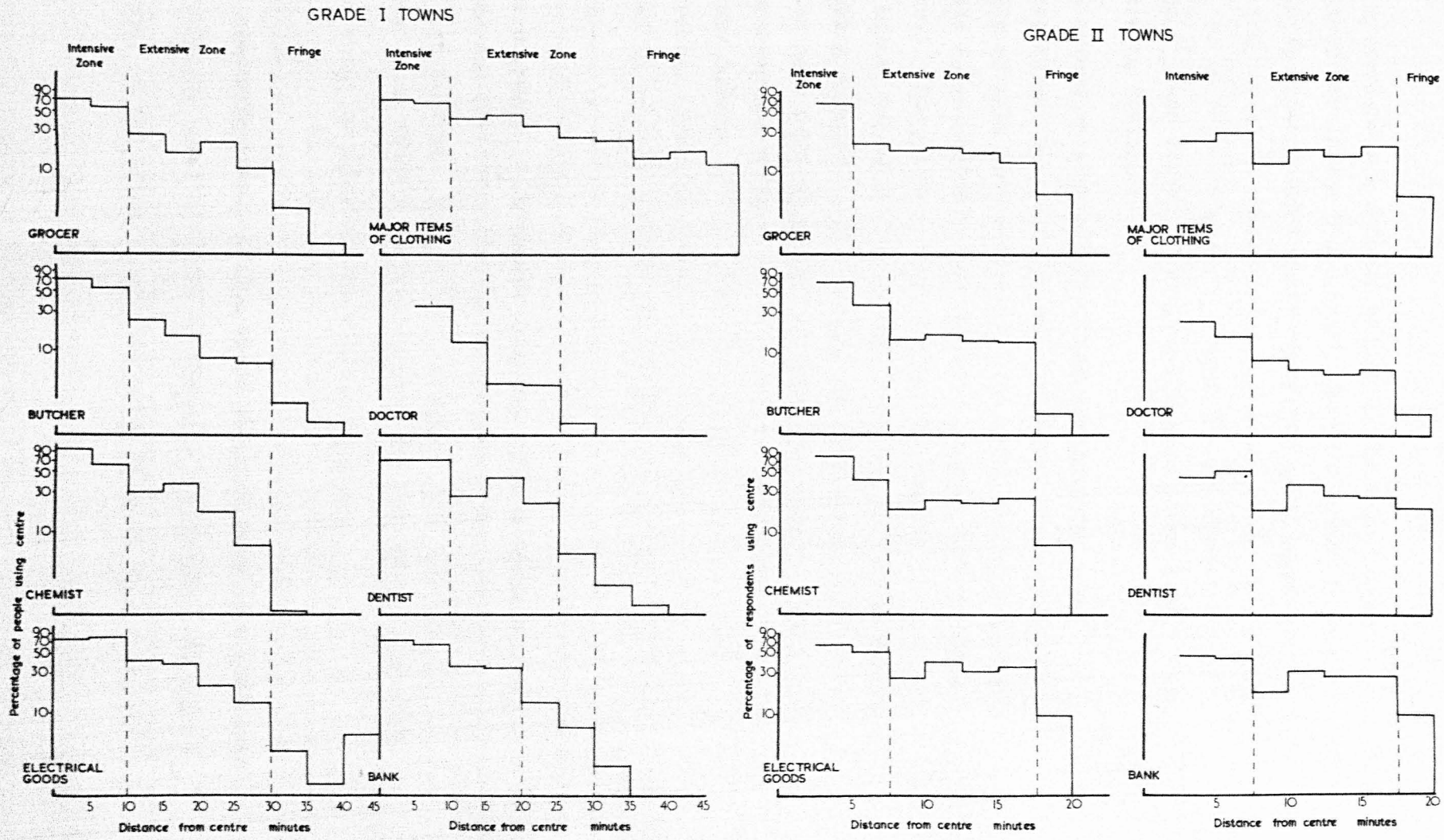


Figure 9.7 Specific compoents of the retail hinterlands of grade 1 and grade 2 centres

of the hinterland are defined simply by the two largest discontinuities in the histogram. By this method it would be possible to distinguish a large number of small zones, but inspection reveals a consistency in the occurence of two major breaks, so on this evidence, and upon the precedents set by Golledge [10] and Bracey [11] three zones were identified. These zones are as follows :-

1. The intensive zone of hinterland affiliation, where the influence of the central town was dominant. The extent and intensity of this zone varied, more for grade 1 centres than for grade 2, according to the order of good or service being considered. For grade 1 towns the maximum extent varied from the 10 minute isochrone for groceries to the 20 minute isochrone for banking services, and although the zone characteristically attracted more than 50 percent of consumers there is competition from suburban and village centres for the lower order goods, and from towns outside of the hinterland area for more sophisticated requirements. Thus for doctors the proportion of rural people attracted to grade 1 centres from this zone was less than 50 percent.

The boundary of the intensive zone for grade 2 towns was for all goods and services, with the exception of groceries, a travel time of 7.5 minutes. The smaller intensive zone recorded for groceries is no doubt a reflection upon the provision of grocery and food shops in suburban and village locations.

2. The extensive zone. A zone where the influence of a town over its surrounding rural district is strongly challenged. As figure 9.7. shows, in the present case the outer edge of this zone for

all goods and services examined is invariably at a time distance of 17.5 minutes for grade 2 towns, but it ranges from 25-35 minutes for grade 1 centres according to the good or service considered. Similarly the intensity of a town's influence, and its rate of decline with distance varied within this zone; 39 percent of consumers were normally attracted to the central grade 1 town for major items of clothing, but less than 10 percent for visits to the doctor. For grade 2 towns there is only relatively weak rural-urban interaction within this zone and the proportion of "tied" consumers did not exceed one third.

3. The fringe zone is a narrow band at the outer limits of a town's area of influence. It is a zone where although the influence of a second town is dominant, a small proportion (usually less than 5 percent) of consumers continue to use the first town. This zone illustrates the imperfect operation of set economic laws. It was found that a small proportion of respondents consistently patronised shops, or shopping centres other than their nearest one. In some cases this behaviour can be ascribed to habits resulting from social contacts , or in connection with the consumer's place of employment, but in others it depends upon differences in individuals' perception of alternative centres.

We see therefore that the hinterland of urban influence exhibits much structural complexity. Even when only a single good or service is being considered the intensity of a town's influence is found to vary throughout its hinterland, and components of this variation can be recognised. Although, as a town centre is approached the proportion of rural people using it for each good or service grows, the position of absolute dominance where the town attracts all of

the consumers from a given locality is rarely achieved, for some degree of competition from adjacent centres is exerted at all points.

This second section of the thesis has presented the results of a case study of rural urban interaction as measured by the way in which central places of different orders influence their surrounding districts. More specifically it has examined the way in which rural people use urban shopping centres, as such it is a study of consumer behaviour patterns in space, and it does not pretend to lay down general laws of spatial behaviour. Various postulates on the nature and measurement of urban hinterlands have been examined, and whilst it is not suggested that the detailed exponents and values would be the same in a totally different rural-urban system, there is a strong likelihood that the general findings would be duplicated elsewhere.

The general conclusions to this section may thus be summarised. The areas of influence of each urban place can be given a boundary, however its depiction by a single line will be a compromise. Not only will it obscure the differing intensities with which different parts of the hinterland are linked to the centre, it also conceals those localities, here termed zones of interference which are not dominated by any single town. For the purposes of establishing retail centrality the most realistic single boundary, and a commonly used one, is that line within which at least 50 percent of locally generated shopping journeys, regardless of purpose, are made to the central town (e.g. figure 8.4). It is important however that this kind of statement should be further qualified with regard to the hierarchical grade of the centres under consideration.

The exponential distance decay function provides a useful and valid generalisation of the hinterland, but far from "nesting" together in a regular and mutually exclusive pattern, hinterlands, even those of towns of equivalent hierarchical order, overlap extensively. The way in which the characteristics of the distance-decay function varies for towns of different hierarchical order suggests that this exercise might be reversed, thus using the distance decay function as a means of identifying hierarchical grades. An examination of more towns, and more variables (e.g. journey to work) would give the methodology and conclusions the firmer foundations which they would require if distance decay functions were to be used in this fashion.

The concept that different goods and services have different ranges was examined. Whilst it could be shown (figures 9.7 7.4 to 7.8) that for some groups of allied goods a town commanded a greater hinterland than for others, in many cases, and especially for lower order central places, the trade areas had a similar extent for many different functions. Equally significant is the fact that the range of a good, or of a function, also varies with the level of demand; in other words it varies according to the rank of the centre from which it is provided. It is suggested too that the concept of the range of a good is weakened in practise by the multi-purpose shopping journey.

The hinterland of a town is not a uniform space; some parts of it are linked more strongly with the centre than others. It is suggested that the structural complexity of the hinterland can be resolved into three zones, here termed the intensive zone, the extensive zone and the fringe.

Most rural people identify strongly with a single town. Although increasing personal mobility had enabled half of the people surveyed to visit more than one town in the four weeks prior to the study, four fifths of all shopping journeys were made to the respondent's first choice, or premier town. This town was either a grade 1 or a grade 2 centre, but second choice towns were commonly centres of higher order than the first choice. The suggest allegiance of rural people to a single town is confirmed.

This section has been concerned with the identification and measurement of rural-urban relationships. Without such attempts to explain and quantify the relationships the nature of urban influence must remain as obscure in details as it is obvious in general.

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Conclusion to Section II

In the first part of this study, (chapters 3 -6) we examined the functional bases of central places and investigated techniques for identifying a functional hierarchy of settlements. The second part has concentrated upon the hinterlands of these settlements. In particular we have investigated the catchment areas, or zones of influence established by the central places, and have scrutinized the rural-urban linkages which have been established by consumers using the towns. As with the first part, specific findings are presented in each chapter, but a few more general conclusions can also be made.

A questionnaire survey enabled the nodal structure of the region to be identified, and it also served to separate those settlements which were actually providing goods and services for a hinterland population, i.e. the true central places, from those whose retail and service facilities served only their own resident populations. The pattern of linkages thus established helps to clarify both the nature and degree of the influence of central places, and it also points to the complex system of interaction between rural consumers and the towns in the area. Different hinterlands and patterns of movement were seen to exist for different kinds of goods and service, but in practise it appears that the concept of the range of a good is no more significant than variations in the geographical ranges of different centres providing these goods.

The problem of delimiting urban hinterlands was examined, and both theoretical and empirical approaches have been applied. Although the shape and extent of hinterlands vary according to the functions considered,there is seen to be considerable similarity between shopping hinterlands derived from a simple gravity model

and those established empirically. There are however also important differences. Lines of communication and the relative trading success of closely adjacent towns distort the theoretical formulations, but, more importantly for our comparison, the empircally determined hinterlands show that (in the current situation) certain areas exist where the influence of no single town dominates. These are termed zones of interference.

The elusive nature of a town's hinterland boundary is illustrated by the overlapping of the areas influenced by different centres. Closer inspection however reveals that despite the overlap of areas of influence, individual consumers are strongly dominated by a single town. The strength of this domination is shown by the fact that 80 per cent of all shopping journeys recorded were made to the sonumser's respective premier, or first choice towns. Three quarters of the remaining trips were directed towards centres of higher order than the consumer's premier town, a pattern of movement which suggests that the towns are being used by rural people in a complementary rather than a directly competitive fashion.

This high degree of allegiance to a single centre is not altogether unexpected. In a rural area such as this the comsumers do not have the range of choice of alternative shopping centres which are commonly found in more densely populated urban areas and we would expect them to be relatively conservative in behaviour. Once rural customers have chosen their premier town and built up a habitual pattern of shopping there are strong forces acting to preserve the status quo. For example, their allegiance to the shops of a particular town will tend to be consolidated, and perpetuated, a loyalty which stems from the habitual use of services such as a bank,an agricultural merchant, a particular livestock market or perhaps a school.

The final chapter is concerned with the structure of urban hinterlands, an aspect of central place study which has previously been almost completely neglected. The way in which the influence of a town declines with distance is shown to be expotential, but the different values for this mathematical function for towns of different status suggests that it may also be a useful diagnostic tool for identifying the ranks in a hierarchy of settlements. The distance-decay function is only a generalisation of the nature of a town's influence, but other factors presented in this chapter confirm that an urban hinterland is not a uniform space, rather it is an area which is structurally complex, and different parts of it are linked to the central town with varying degrees of intensity.

This study of the 'use characteristics' of central places is essentially complementary to the preceding assessment of urban functional provision, which in itself presents an incomplete picture of settlement centrality. The possession of a particular function, or group of functions by a settlement does not necessarily prove that the settlement is acting as a central place for a surrounding area. This thesis therefore examines centres within their regional, or sub-regional contexts, and describes the linkages which they have with their service areas in addition to measuring their functional provision. It is only by considering the two aspects together that a comprehensive interpretation of a system of central places can be attempted.

Appendix A

The following table indicates the number of retail and service establishments in each settlement within the study area, as well as details of their population and social organisation. The source of each item of information is given below, but it should also be noted that in many cases it was possible to cross check data from two or more sources.

COLUMN

1) The population figures for the urban areas are drawn from
2) the 1961 census volumes. Village populations were computed by multiplying the number of private dwellings (as listed in the Rating and Valuation Lists of local authorities) by an occupancy ratio of 3.03 persons per dwelling.

3-50 Field Survey

51 Midlands Region G.P.O. Headquarters

52 Field Survey and telephone directories

53 County Medical Executive Council Lists

54 County Medical Executive Council Lists

55 Opticians register 1967

56 The Law List 1967

57 Institute of Chartered Accountants Year Book 1967

58 Classified Telephone Directory

59 Classified Telephone Directory

60 Rating and Valuation Lists and Field Survey

61-63 Field Survey

64 County Education Committees

65 County Education Committees

66 Telephone directory

67 County Librarians lists

68 Telephone directory

69 County branches of the Council of Social Service

70-75 Information relating to the number of social organisations in each settlement was gathered only for non-urban centres because it was felt that in towns such organisations are mainly suburban functions which do not add to the settlement's centrality. Details recorded in these columns were gathered from a questionnaire administered by the county branches of the Council of Social Service.

| | 1 POPULATION 1961 | 2 POPULATION 1967 | 3 NUMBER OF RETAIL ESTABLISHMENTS [CENTRAL AREA] | 4 GROCER GENERAL STORE | 5 GROCER GREENGROCER | 6 SUPERMARKET | 7 GREENGROCER | 8 BUTCHER | 9 FISH POULTRY GAME | 10 BAKER | 11 DELICATESSAN | 12 FOOD TOTAL | 13 FOOD SHOPS AS % OF TOTAL | 14 NEWS. CONFEC. TOBACCO | 15 FLORIST | 16 MEN'S BOY'S CLOTHES | 17 LADIES OUTWEAR | 18 LADIES "ONE LINE" CLOTHING | 19 DRAPER, GENERAL CLOTHING | 20 LADIES/GENTS OUTWEAR | 21 BOUTIQUE | 22 FOOTWEAR | 23 CLOTHING TOTAL | 24 OFF-LICENCE | 25 IRONMONGERY, HARDWARE | 26 ELECTRICAL, RADIO, T.V. | 27 GAS/ELECTRIC SHOWROOM | 28 CAR ACCESSORIES & CYCLES | 29 FURNITURE | 30 FURNISHINGS, CARPETS | 31 WALLPAPER, PAINT, D.I.Y | 32 HOUSEHOLD GOODS TOTAL | 33 CHEMIST | 34 JEWELLERY | 35 BOOKS, STATIONERY | 36 LEATHER GOODS | 37 ANTIQUES | 38 GIFT SHOPS | 39 PHOTOGRAPHIC GOODS | 40 MUSIC, RECORDS | 41 PET SHOPS | 42 TOYS, MODELS | 43 SPORTS EQUIPMENT | 44 GARDEN STORES | 45 OFFICE SUPPLIES | 46 SECOND HAND GOODS | 47 VARIETY STORES | 48 DEPARTMENT STORES | 49 TOTAL NON FOOD & CLOTHING | 50 VACANT | 51 POST OFFICE | 52 BANK | 53 DOCTOR | 54 DENTIST | 55 OPTICIAN | 56 SOLICITOR | 57 ACCOUNTANT | 58 AUCTIONEER | 59 VETINARY SURGEON | 60 LADIES HAIRDRESSER | 61 DRY CLEANER | 62 TURF ACCOUNTANT | 63 TRAVEL AGENT | 64 PRIMARY SCHOOL | 65 SECONDARY SCHOOL | 66 DISTRICT NURSE | 67 LIBRARY | 68 POLICE | 69 VILLAGE HALL | 70 CHURCH ORGANISATIONS | 71 WOMEN'S CLUBS | 72 YOUNG PEOPLE'S CLUBS | 73 SPORTS CLUBS | 74 MISCELLANEOUS CLUBS | 75 TOTAL SOCIAL ORGANISATIONS |
|---|---|---

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
BROMSTEAD HEATH	249	281	3	3								3	100.							

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
IGHTFIELD	139		1	1								1	100.							

Function	Urban Centres		Non-Urban Centres		Central Villages		Grade A Villages		Grade B Villages		Grade C Villages		Grade D Villages	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Gen Store/Grocer	58	4.0			49	22.1	56	33.3	65	78.3	90	100	47	100
Grocer/Greengrocer	10	0.7			8	3.6	9	5.4	2	2.4				
Supermarket/Self-Service	36	2.5			5	2.2								
Greengrocer/Fruit/Flowers	32	2.2			10	4.5	5	3.0						
Butcher	76	5.3			25	11.2	20	11.9	5	6.0				
Baker	61	4.2			6	2.7	3	1.8						
Other Food	23	1.6			2	1.0								
Food Total	296	20.5	407	66.7	105	47.3	93	55.3	72	86.7	90		47	
Confectionery/Newsagent/ Tobacconist	101	7.0	35	5.7	18	8.1	13	7.7	4	4.8				
Mens/Boys Clothes	71	4.9			2	0.9								
Womens/Childrens Clothes	158	10.9			15	6.8	4	2.4						
General Clothing/Draper	58	4.0			7	3.2	1	0.6	3	3.6				
Footwear	87	6.0			8	3.6	4	2.4						
Clothing Total	374	25.9	55	9.0	32	14.4	20	11.9	3	3.6				
Ironmongers/Hardware	45	3.1			13	5.9	14	8.3	1	1.2				
Electrical/Radio/T.V.	68	4.7			9	4.1	7	4.2						
Gas/Electricity	23	1.6			2	0.9								
Cycles/Car Accessories	35	2.4			10	4.5	1	0.6						
Furniture/Furnishings	147	10.2			6	2.7	2	1.2						
Household Hardware Total	317	22.0	65	10.7	40	18.0	24	14.3	1	1.2				
Chemist	41	2.8	18	3.0	9	4.1	8	4.7	1	1.2				
Other non-food	312	21.7	30	4.9	18	8.1	10	5.9	2	2.4				
Total	1441	100	610		222	100	168		83		90		47	

Central villages are equivalent to Grade 3 settlements in table 6.3
Grade A villages = Grade 4 settlements Grade B villages = Grade 5 settlements
Grade C villages = Grade 6 settlements Grade D villages = Grade 7 settlements

Appendix C

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APPENDIX D

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&JOB ; GER006 ; HIERARCHICAL GROUPING
SWOP

&FORTRAN ;

&LIST ;
   1* C
   2* C    HIERARCHICAL GROUPING PROGRAM  P.KIVELL - AFG   MAY  1970
   3* C
   4*      DIMENSION X(200) , MARK (200), MNITEM (200) , SUMSQ (200) , SUM (200) ,
   5*     1MNAME (5,200)
   6*      TOL = .5E-8
   7*      READ (7,10) NSET, IFLOG
   8*  10  FORMAT (215)
   9*      IFLOG = IFLOG + 1
  10*      WRITE (2,15)  NSET
  11*  15  FORMAT (1HO,  40X,  29 HHIERARCHICAL GROUPING PROGRAM  // 40X,22HINITIA
  12*     1L NO OF SUBJECTS, 18 // 30X,  4HNAME, 18X, 5HSCORE)
  13*      GO TO (20,17), IFLOG
  14*  17  WRITE (2,19)
  15*  19  FORMAT (1H+, 69X, 12HLOG OF SCORE )
  16*  20  DO 30 ISET = 1, NSET
  17*      READ (7,22)  (MNAME (IWORD,ISET), IWORD = 1,5), X(ISET)
  18*  22  FORMAT (5A4, F10.0)
  19*      WRITE(2,24)  (MNAME (IWORD,ISET), IWORD = 1,5), X(ISET)
  20*  24  FORMAT(20X,5A4,5X,F15.6)
  21*      GO TO (30,26),IFLOG
  22*  26  X(ISET) = ALOG10(X(ISET))
  23*      WRITE(2,28) X(ISET)
  24*  28  FORMAT(1H+, 66X,F15.8)
  25*  30  CONTINUE
  26* C
  27*      NSETM1 = NSET - 1
  28* C
  29*      WRITE(2,35)
  30*  35  FORMAT(1H1, 48X, 5HNO OF, 40X, 5HNO OF/ 49X, 5HITEMS, 40X,
  31*     15HITEMS/ 10X, 9HCYCLE NO. , 7X, 4HISET, 18X,7HIN ISET,17X,
  32*     24HJSET, 17X,  7HIN JSET,12X, 7HMIN ESS //)
  33* C
  34*      DO 40 ISET = 1,NSET
  35*      MNITEM(ISET) = 1
  36*      SUMSQ(ISET) = X(ISET)**2
  37*      SUM(ISET) = X(ISET)
  38*      MARK(ISET) = ISET
```

```
39*  40  CONTINUE
40*      ICYCLE = 0
41*  42  ESS = 9000000.0
42*      MARKI = 0
43*      MARKJ = 0
44* C
45*      DO 100  ISET = 1,NSETM1
46*      IF (MARK(ISET)) 100, 100, 45
47*  45  ISETP1 = ISET
48*  46  ISETP1 = ISETP1 + 1
49*      IF ( ISETP1 .GT. NSET ) GO TO 100
50*  48  IF (MARK(ISETP1))46, 46, 50
51*  50  TESS = SUMSQ(ISET) + SUMSQ(ISETP1) - ((SUM(ISET) + SUM (ISETP1))
52*     1                              **2 / (MNITEM(ISET) + MNITEM(ISETP1)))
53*      DO 52 KSET = 1,NSET
54*      IF (KSET .EQ. ISET .OR. KSET .EQ.ISETP1 .OR. MARK(KSET) .EQ. 0)
55*     1 GO TO 52
56*      TESS = TESS + SUMSQ(KSET) - ((SUM(KSET))**2/ MNITEM(KSET))
57*  52  CONTINUE
58*      IF (TESS - ESS) 55, 100, 100
59*  55  ESS = TESS
60*      MARKJ = ISETP1
61*      MARKI = ISET
62*      IF (ESS - TOL) 110, 110, 100
63*  100 CONTINUE
64* C
65*  110 WRITE (2,120) ICYCLE, (MNAME(IWORD,MARKI), IWORD = 1,5),
66*     1MNITEM(MARKI),(MNAME(IWORD,MARKJ), IWORD = 1,5), MNITEM(MARKJ),
67*     2ESS
68*  120 FORMAT( 10X, I5, 8X,5A4, 8X, I4,15X.5A4, 8X I4, 3X, F15.6)
69*      MARK(MARKJ) = 0
70*      SUMSQ(MARKI) = SUMSQ(MARKI) + SUMSQ(MARKJ)
71*      SUM(MARKI) = SUM(MARKI) + SUM(MARKJ)
72*      ICYCLE = ICYCLE + 1
73*      MNITEM(MARKI) = MNITEM(MARKI) + MNITEM(MARKJ)
74*      IF(ICYCLE - NSET + 2 ) 42,42, 200
75*  200 STOP
76*      END
```

(Notation: I = Capital letter i
1 = Numeral one.)

APPENDIX E The Questionnaire

In order to establish the pattern of shopping frequencies and destinations of rural consumers in the study area, a questionnaire approach was adopted. To select the best method of establishing these patterns a small scale pilot survey was conducted in Newcastle R.D.C. in 1968. This enabled a comparison to be made between different sample frames, different survey techniques and particularly the merits of postal questionnaires versus face to face interviews, and it also helped to distinguish the problems of time, expense and manpower which would be involved in collecting the data.

The aims of the survey, as with any such, were to minimise the inspectory effort and fieldwork required to gather the necessary information. This information formed three categories :-

(1) the identification of the towns and villages where rural people obtain a selected range of goods and services. In order to maximise the reply rate, this list was as short as possible and comprised nine commonly required goods and services.

(2) To ascertain the frequency with which respondents visited different centres, and the relationship of this frequency to such factors as distance.

(3) An indication of the way in which towns exert an influence over their surrounding rural districts as measured by the allegiance of rural people to one or several centres.

The pilot survey indicated that within the limits of available time and money a postal questionnaire would best achieve these aims, and on this basis a full scale survey was mounted.

It was decided that the household would be the basic unit for questioning, partly to avoid the bias which might be introduced by variations in place of work, and partly to achieve consistency throughout the area. Two and a half percent of all households in rural areas were questioned, a figure limited by the funds

available but adequate to give complete geographical coverage.

The choice of sample frames was very limited, but the valuation lists of local rating authorities provided a suitable base. The advantage of this sample frame are :-

(1) it gives a complete coverage of all households, including those where the nominal head of the household is under 21

(2) it is constantly amended and is therefore always up to date

(3) it is easily available at a limited number of central locations, i.e. the offices of the rating authority

(4) the rateable value of each domestic dwelling provides a ready check on the socio-economic status of respondents and non-respondents alike.

An interval sample of 1/40 provided the required address list, and although the arrangement of dwellings by location in the valuation lists causes this to be not a purely random selection, it is quasi-random and sufficiently accurate to remove any unintentional bias.

The introductory letter and the questionnaire itself are reproduced in figure E.1. In order to maintain the interest of the respondents both letter and question form were kept as short and simple as possible, and although this restricted the nature and number of questions which could be posed, it has been justified by a favourable response rate. Since this was purely a fact gathering survey, and not one designed to test attitudes or opinions, the questions were open-ended but designed to ellicit a one word answer. An index number on each questionnaire enabled the location of the respondent to be plotted.

The results of the postal questionnaire were most satisfactory, although as with all such surveys there was a large number of people who did not reply through choice, infirmity or absence from home. The useable response rate is detailed in Table 1.

TABLE 1

	No.	Percent
Questionnaires despatched	1185	
Returned complete	695	58.6
Returned incomplete	7	0.6
Spoilt papers	5	0.4

Thus 58.6 percent of those questioned returned fully useable replies, and an additional 0.6 percent were suitable for partial analysis.

A χ^2 test revealed that there was no significant difference between the rateable value of the dwellings of non-respondents and those of the total sample.

Figure E.1.

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Geography Department

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KEELE, NEWCASTLE,
STAFFORDSHIRE. ST5 5BG
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Dear Sir/Madam,

As part of an examination of the towns and villages of this area I am conducting a survey on the importance of the different shopping centres. Obviously it is impossible to ask everybody where they go to do their shopping and your name has been selected at random from the Rating List. The survey is entirely confidential throughout.

The attached questions should only take a few minutes and I would be grateful if sometime during the next week you could complete the answers and return the form to me. A stamped addressed envelope is enclosed for this purpose and it should be left unsealed. In order to make this survey accurate it is important that as many people as possible should reply.

Thank you for your co-operation.

Yours faithfully,

(P.T. Kivell).

Figure E.1.

1. Which town or village do you normally visit for the following?

Grocer	.....
Butcher	.....
Post Office	.....
Chemist	.....
Electrical Goods	.....
Major items of clothing	.....
Doctor	.....
Dentist	.....
Bank	.....

2. Do you have the use of a Car? Yes.....No.....
   Is it available for shopping trips
   a. Always?
   b. Only at weekends?
   c. Occasionally?

3. Which towns have you visited <u>for shopping purposes</u> in the last four weeks, and how many visits have you made to each? (for example Market Drayton 2).